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SPOLIATION OF THE FALLS OF NIAGARA[1]

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1. *First Reference to Niagara—Champlain.*—A few weeks hence there will be celebrated the three-hundredth anniversary of the foundation of the city of Quebec, by the Great Champlain. Out of this grew the Dominion of Canada. Although the establishment of the little settlement on the St. Lawrence River made Champlain most famous, it is not in this that his chief greatness lay, but rather in his wonderful explorations in the lake region of the interior of the continent, throughout a long life spent in the wilderness.

Jacques Cartier had ascended the St. Lawrence in 1535 and again a few years later. Champlain followed in his tracks as far up the river as Montreal (in 1603) five years before the settlement of Quebec. From the summit of the old volcanic mountain at Montreal he saw the first or Lachine rapids of the St. Lawrence, above which he could discern the smooth water of the expanded river, now known as Lake St. Louis. Here he received accounts from three different Indians as to the nature of the country beyond. Their communication must have been largely carried on by signs and diagrams, drawn on the sand. Although the first volume of Champlain's works is extremely rare, the accounts were transcribed by Lescarbot in his history of New France, published soon after, in 1609. The description of the rapids and various lake-like expansions of the St. Lawrence, the Thousand Islands, Lake Ontario, the occurrence of Niagara with its rapids, and Lake Erie reaching to Lake Huron "beyond which no man had been," were all so complete that a navigator unimpeded by hostile Indians could easily have found his way. But the natives were hostile, so that Lake Huron came to be known long before Lake Erie and the Niagara River.

2. *First Account of Niagara River.*—Champlain never saw Niagara,

[1] Address before the American Association for the Advancement of Science, June 30, 1908.

FIG. 1. FALLS OF NIAGARA, CANADIAN BRANCH, 1809. (By permission of Baker Art Gallery, Columbus, Ohio.) Sheet of water to the right of line *bb* (west side) has since been curtailed 415 feet, on account of power diversion. The falls to the left of line *aa* are being drained by the diversion, which, when it reaches the franchise amount, will leave 800 feet of bare rock on the Goat Island or eastern side, thus throwing the remaining falls entirely into Canadian territory.

but on his map of 1632 he represents a long series of rapids, located at the end of Lake Ontario, and says concerning them, "A very high fall of water at the end of the rapids of St. Louis (a name given to Lake Ontario) where many kinds of fish in descending are stunned." That the river was famous among the Indians, on account of the falls, and possibly among a few "*Courreurs de bois*" and missionary priests, is certain, as Father Lalement, who first mentions its name (Onguaahra), speaks of it as "so celebrated." This was in 1641, yet he does not mention the falls. In 1645, Dr. Gendron wrote a letter about the falls, but this was not published until 1660; in the meanwhile (1648) Father Ragueneau mentions them as occurring on Niagara River. This was the beginning of the historic period.

3. *Approaching Peril to Niagara Falls.*—The Falls of Niagara are now entering another and much more critical epoch in their history. The time has not arrived when their use has become a necessity, and even in their spoliation, other and larger interests are at stake. Niagara is a world possession, yet its very existence is imperilled by the greed of a few persons, or for the exigencies of politicians.

4. *Commission for Investigation.*—Extended operations were already at work upon the falls, when Dr. Robert Bell, Canada's most distinguished geologist, at the head of the Geological Survey, commissioned me, three years ago, to make a complete investigation upon the recession of Niagara Falls, so as to record the undisturbed work of nature, and also to determine how far the falls could be diverted without bringing about unforeseen disasters.

5. *Opinions of Power Diversion.*—At that time, in the opinion of some serious observers, the falls were imperilled, and Dr. John Clarke, state geologist of New York, pointed out the impending destruction of the American Falls. There were also many sensational magazine articles, bearing on the same subject, but in these no data were given by which to form judicious opinions. On the other hand, those interested in the diversion of the water insisted that no serious damage would be done. Personally I had no opinion whatever, though I regretted the disfigurement of the falls, through the structures erected by the power companies, one such being placed even beneath the cataract itself, inside the Park Reservation on the Canadian side, especially offensive as seen from the American side (shown in a succeeding plate, figure 8).

6. *International Waterway Commission established for saving the Falls.*—Before this time, the late Honorable Andrew H. Green had secured the passage through Congress of a bill, authorizing the establishment of an International Waterway Commission, his specific object being the preservation of Niagara Falls. Indeed it was for this same object that the International Park at Niagara had been established at an earlier date, largely through the efforts of the Earl of Dufferin,

Governor General of Canada, and Mr. A. H. Green, of New York, who subsequently prevented the intrusion of all power structures in the state reservation on the New York side, a policy unfortunately not followed by the government on the Canadian side. Here even the park was widened, at the cost of the falls, in curtailing their crest-line by several hundred feet. Yet among those interested in the power companies it was commonly said that they were improving the park; a few, who were powerless, seeing through this sophistry. That public opinion was swayed by such representations is not to be wondered at, for at a later date, April 26, 1906, the Canadian section of the commission states that, "It would be a sacrilege to destroy the scenic effect of Niagara Falls, unless and until the public needs are so imperative as to compel and justify the sacrifice" (p. 102), and yet they suggest no curtailment on the Canadian side. The report further says that, "It is possible to preserve the beauty, and yet permit the development on the Canadian side of the Niagara River"—of a certain amount of power on which I shall comment later, but no data are given on which the above statement is based. Indeed, I was unable to form any opinion whatsoever until my own investigations were made, which were begun before the proceedings of the International Commission, and not completed until some time after the premature report, cited above, appeared in print.

7. *Results, the Outcome of Purely Scientific Investigations.*—The conclusions reached concerning the spoliation of the Falls of Niagara are the outcome of investigations into purely scientific problems, and a brief account of them may show more convincingly how these results have been obtained. Just twenty years ago, I had the honor of announcing to this association the discovery that Lake Huron, with Michigan and Superior as tributaries, formerly emptied to the northeast, and did not discharge into a shrunken Lake Erie; and, consequently, Niagara was then a very small river. Six years later, I again laid before this association additional observations indicating that the falls had receded nearly three miles, when the Huron drainage was turned into Lake Erie; and with the fragmentary data bearing on the discharges of the rivers, an attempt was made, with only partial success, to determine the size of the original Niagara River.

One of the chief problems of my latest investigations was to determine the volume of the Niagara River in its early stages. It was not a simple matter, for contradictions appeared in the data obtained, which had to be eliminated. This involved the whole question of the physics of the rivers, requiring months of labor to collect the data and analyze them. In this connection, I found that the outlets of both Lake Erie and Lake Ontario had been recently lowered, while Mr. Thomas Russel, of the U. S. Lake Survey, had previously made the great discovery that

the outlet of Lake Huron had also been lowered. This was the starting-point of the investigation into the spoliation of Niagara. The channel of the river had been deepened just after 1890, owing to natural scour by the currents, the effectiveness of which was increased by the powerful jamming of vast quantities of ice against the barriers at the Upper Rapids, immediately above the falls, and to a small extent by the shifting of the boulders on the river bed just below the outlet of Lake Erie.

8. *Corrections of Discharge Measurements.*—The discharge measurements had been made by the U. S. Lake Survey after the lowering of the lake outlets had occurred, that of the Erie outlet causing the subsidence of the lake level to nearly one foot. As the daily records of the lake fluctuations have been kept for fifty years or more, it was possible to determine the discharges of the rivers throughout that time. Failing to take into consideration this lowering of the lake outlets, the calculations of the river discharges prior to 1891 were excessive, and those of Lakes Huron and Erie showed inadmissible differences; as also found by Mr. Russel. These discoveries reduce the calculated discharge of Niagara River, prior to 1891, by 22,000 cubic feet per second, which would bring its volume from 1860 to 1890 into agreement with the mean measured discharge for the fifteen years from 1891 to 1905, inclusive, or 204,000 cubic feet per second; and the low water discharge has fallen to 160,000 cubic feet. There have been years of high water and others of low, yet by taking groups of years, the mean values are remarkably uniform, but the latter period must not be regarded as one of low water, a fact which I can not too strongly emphasize, although the lake levels have actually been much lower than during the preceding period, due, as just stated, to the lowering of the outlets. Such years, however, as 1901, showed very low water in Lake Erie, and reduced discharge of Niagara River.

9. *Present very High Water.*—In contrast with this, the lake-levels during 1907 were extraordinarily high, increasing even till the present month (June, 1908). Fragmentary information, preserved, indicates that Lakes Erie and Ontario were unusually low in 1819. The fuller record of subsequent years shows that the highest water occurred in 1838, and nothing has been comparable to it until the present high stages. Although these do not make the lakes appear to be now so high as seventy years ago, this is because of the lowering of their outlets and the further diversion of water for power purposes, both of which, if allowed for, would bring the lakes to higher levels than at any time since records have been kept. The 1838 period of high water began in that year and continued until 1840, after which the lake levels subsided to normal conditions. There is no reason to suppose that the present extreme high-water conditions will continue longer than

FIG. 2. VIEW OF UPPER RAPIDS, at the head of which is the rock-rim determining the distribution of water, as it leaves the basin above (descent 55 feet). This rock-rim also determines the level of the Upper Lakes.

on previous occasions, although I am aware of a statement by an engineer holding a distinguished position, to the effect that we do not know that the levels are going to recede. This appears to have been said for politic reasons, as the pressure to further divert the water is very strong.

There is much popular curiosity as to the cause of the high water, which is not wholly explained by the rainfall. Mr. E. S. Wheeler, of the U. S. Lake Survey, found in his elaborate study of the physics of the rivers that changes could be produced by ice jams holding back the discharge and raising the lake so high that upon the melting of the snows together with spring rains, the waters could not run out sufficiently fast during the ensuing season, so as to bring the levels of the lakes to their normal condition. These effects could accumulate during succeeding seasons so that the extraordinary stages might last not merely one year, but for several years.

From the foregoing, it must be apparent to any one that no opinions can be formed on power diversion which ignore the fluctuations of lake levels, for as these vary, so do the discharges of the rivers. The mean discharge of the Niagara River for 1901, a year of very low water, was 14,000 cubic feet per second below that of the mean level from 1891 to 1905. This was after the abstraction of a certain quantity of water, the exact amount of which is unknown to me, but probably not reaching 10,000 cubic feet per second. The mean discharge during 1907 reached 15,000 cubic feet per second above the average of the fifteen years mentioned; this being after the artificial abstraction of nearly 18,000 cubic feet per second. Thus the entire diversion of the Niagara waters has been not only concealed by the extraordinary stages of the river, but a further quantity could be withdrawn without any apparent effect upon the falls. The increasing discharge of Lake Erie, during this year, reached the maximum on April 27, when it rose to 60,000 cubic feet per second above the average of the fifteen years mentioned, besides which the diversion was probably nearly 18,000 cubic feet; so that the full use of the franchises of the present power companies would not impair Niagara Falls to-day, but this condition can not last, and it is unfortunate that it should occur at this time, for the sake of those who are interested in the preservation of the falls, as well as in the navigation of the lakes.

In studying the physics of Niagara River, individual months or single years can not be adopted as standards, but I have found that satisfactory results can be obtained by taking groups of five-year periods. Perhaps some other arrangement might prove better. This has resulted in my adopting as standards of lake levels and river discharges, the means of the fifteen years succeeding the lowering of the lake outlets, and the present temporary high water will doubtless

adjust itself in the general averages, as on previous occasions, so that we must consider the effects of power diversion under normal conditions. As stated before, when the corrections are made in the discharge calculations prior to 1891, they fall into harmony with those of more recent date. These corrections do not appear in the work of any other writer, but I find them necessary, in order to explain incongruities, and to arrive at a satisfactory understanding of the effects of power diversion on Niagara Falls and the Great Lakes. Under these conditions, let us examine the physics of Niagara River.

10. *Basin above the Rapids.*—Above Niagara Falls are the Upper Rapids, descending fifty-five feet to the brink of the cataract. These begin as the water passes over a rim of rock (see figures 2, 3, 5) which crosses the river at the head of Goat Island. This is the "critical point," not merely in the distribution of water over the falls, but also in the level of Lake Erie, and indirectly of Lakes Huron and Michigan. Except at one small part near the Canadian side, the rock rim is from two to five feet higher than the rock-floor of the shallowest part of the river, about seventeen miles above the head of the Upper Rapids, and two miles below the outlet of Lake Erie. Throughout this distance the river crosses a depression, refilled with drift, so that here the channel itself was easily excavated to a much greater depth than across the two rock barriers mentioned, thus forming, *de facto,* a basin beginning with the narrows at the Buffalo Water Works, which are only 1,850 feet across, soon widening out into the broad stretches of the river on either side of Grand Island, below which they unite into another basin, over a mile wide, above Goat Island and its associated rock rim. This from its greater height than at the Water Works, constitutes the true rim of the Erie basin. The slope of the river between these points is due to the narrowness of the outlet of the lake, where the waters are so piled up that they have a velocity reaching to eight miles an hour, while in the basin above Goat Island the current is reduced, and is there from two to four miles an hour. The descent of the river from the lake to the rock rim at the Upper Rapids is about twelve feet.

11. *Depth of Water on the Rim of Upper Rapids.*—At mean stages, the average depth of the water in the American channel, as it begins to flow past Goat Island, is less than three feet, with a maximum of 4.5 feet. In the Canadian channel, for some 400 or 500 feet from Goat Island, under present ordinary conditions, the water is only from half a foot to one foot in depth, then for another stretch it increases to between two and three feet, beyond which the river shoals, so that in ordinary stages the water is seen to descend, not only in almost broken streams, but it is so shallow that the floats which have been sent down the river do not pass over the rock ledges, but are carried by the

dividing currents on either side. Thus for perhaps half of the river from the Goat Island side, I have estimated the mean depth of the water over the rock rim as not exceeding two feet. Indeed, much of it is not over a foot in depth. Nearer the Canadian side it increases to nine feet (see figures 3 and 5).

FIG. 3. PROFILE OF RIM OF FIRST CASCADE, with forebay of Ontario Power Company in foreground.

12. *Portion of Falls in Immediate Peril.*—As the river is so shallow over the rock rim on the Goat Island side of the main channel, it forms only a thin sheet of water on the eastern side of the Canadian or Horseshoe Falls, for a distance of 800 feet from the Goat Island end. Indeed, from the changes already effected, this sheet of water has been reduced in depth by sixteen inches, thus in many places exposing the shelf of rock over which the rapids are passing (figure 4). This portion of the falls I had considered as being in most immediate peril, even more so than the American Falls, but recent soundings, about the head of Goat Island, show that a rocky floor extends almost across to the main shore of New York, which in the future must divert to a large degree the supply of water from the American channel between the island and the shore. Accordingly, the American Falls are in equal danger with the eastern side of the Canadian cataract.

I hope that in this study of the physics of the river, the importance of this rim has been sufficiently emphasized; for any lowering of the water in the basin, will cause the draining of the higher parts of this rocky barrier, which extends nearly two thirds of the breadth of the

FIG. 4. EASTERN SIDE OF FALLS BEING DRAINED. Power House in the background is situated in the park on the Canadian side.

channel from Goat Island—thus affecting most the eastern side of the falls. If it were broken through, as it will be in the distant future by the recession of the falls, the water in the basin would be immediately lowered, and the Upper Rapids would reappear as a cataract just below the Buffalo Water Works, where the rock-floor is now seventeen feet below the surface of the river, while at a mile and a quarter farther down the drift has already been excavated to a depth of fifty-three feet.

13. *Artifical Openings now made in the Basin.*—It is immaterial whether the artificial enlargement of the orifice to the basin be made across the rim, or from its sides, or from the bottom. One lateral channel has been made for a breadth of 100 feet, and a depth of fourteen feet below the surface of the basin. There is also a neighboring one of about equal proportions. These made channels consequently reach depths much below the general level of the rock rim. They constitute the intakes of the two power companies on the New York side, and were calculated to carry 14,500 cubic feet per second at low stages (see map, figure 5).

On the Canadian side, the Ontario Power Company has installed a peculiar structure at the end of the rock rim, above which the river has a depth of five or six feet. Just below, at the natural edge of the basin, they threw out a wall, forming a wing-dam of some eight acres. This wall was brought to about the height of the river floor above.

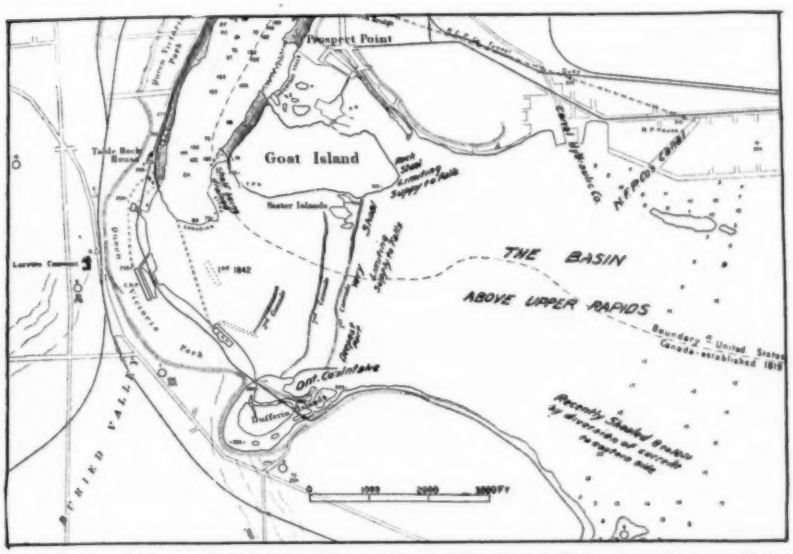


FIG. 5. MAP SHOWING THE POSITION OF THE FIRST CASCADE AND THE BASIN WHOSE LEVEL IS NOW BEING LOWERED BY THE POWER COMPANIES.

The effect of this is to extend forward the rock rim of the basin. Behind this wall, they removed the rock floor, in some places to a depth of seven feet, so that there is now a general depth in their dam of some six feet below the surface of the barrier, over which the water flows as if naturally. By taking the water from the bottom of the dam, while the river is still flowing over the top, the same effect is produced as if it were taken by a tunnel from any part of the floor of the basin of the Upper Rapids, and so increases the discharge from the basin.

The franchise of the Ontario Power Company is about 12,000 cubic feet per second, but works for only 4,000 cubic feet are completed. Their franchise has not been restricted as have been those of the New York Companies. The present amount of water due the New York Companies, as restricted under the Burton Act, is 14,500 cubic feet per second, although their franchises gave them 27,200 cubic feet per second.

These detailed accounts are given to show unequivocally, despite assertions to the contrary made to me by Mr. George C. Gibbons, chairman and legal representative of the Canadian section of the commission, that not only the older New York Companies, but also the Ontario Power Company (the other Canadian companies' works being below the rapids) must lower the water in the basin above the Upper Rapids. Indeed, Mr. Gibbons signs the report stating that if the water-supply were taken from Chippawa Creek, Lake Erie would be lowered, as the supply would come from back-water derived from Niagara River. This back-water would be flowing from the same basin which has been

described, consequently there can be no difference whatsoever from what point of the basin the water is diverted.

14. *Water taken from One Side of Basin affects the Other Side.*—That water can not be taken from one side of the basin without affecting the level on the other side is shown by the fact that, since the two New York companies began operations, the depth of the river, which is a mile across, near the mouth of Chippawa Creek, has been shoaled to the extent of eight or ten feet by the deposit of mud, owing to the slackened current in this part of the basin. So, also, when the power of the Ontario Company comes to be fully used, they will lower the water on the American Falls. Another proof of the diversion of water from the Canadian shore by the New York companies is the shoaling of the river just above the falls, where it was found necessary to throw a barrier to catch the water for the small local power plant, as the level of the river had sunk below the normal stage by the time one of the larger Canadian power plants was ready to begin operations.

15. *Power Diversion below the Upper Rapids.*—There are two other power plants situated in the Canadian Park, but below the Upper Rapids. Consequently, they lose much by their inferior head of water. This is a great gain, in that, taking the water some fifty feet below the basin, the overflow of the rim is not increased, so that this diversion produces no effect whatever on the lowering of the lake levels, or on the American Falls, or eastern side of the Canadian. These companies take the water from the deepest part of the channel, and consequently their effect is least apparent. Their aggregate allowance is about 20,000 cubic feet per second, or a net of 235,000 electric horse-power. However, much damage has been done to the western side of the falls, largely owing to the Canadian Niagara Power Company, on account of which the widening of the park has shortened the crest of the Horseshoe Falls by 415 feet, leaving in place of the sheet of water, a dark wall of rock stretching out into the gorge. It is strange that this impairment seems already to be almost forgotten except by a few lovers of the great cataract, but on looking at the Canadian Falls from the upper bridge the effect is to reduce the diameter apparently by one fourth (see figure 1).

16. *Water taken by Canals.*—The Welland and Erie canals divert less than 2,000 cubic feet per second, and, while the Chicago drainage canal takes at present scarcely more than 4,000, its rights extend to 10,000 and they want 14,000. The diversion by the Chicago canal of 10,000 cubic feet produces varying effects in the different basins, but it may be given at a lowering of the lakes by six inches, or some three inches for the basin at the Upper Rapids.

17. *Effect of Power Diversion on the Falls.*—We are now in a position to determine the effect of power diversion upon Niagara Falls and upon the navigation of the lakes. The water taken from below the

rim on the Canadian side may be omitted from the present discussion. This leaves a volume of 51,200 cubic feet per second, including that of the Chicago canal, conceded under the franchises, though temporarily limited to 44,500 cubic feet. At the beginning of 1908 there were approximately only 18,000 cubic feet per second in continuous use out of the amount affecting the basin (and this quantity may have been considerably reduced from the shutting down of some works), yet this diversion, together with the scour on the river, has lowered the water in the basin, immediately above, so that its level is sixteen inches lower than what it would have been, if no such changes had been effected. Half of the amount is due to the diversion of the water. It is this lowering of the water, just before passing the rim of the basin, at the head of the Upper Rapids, which is causing the lowering of the water on the falls, as shown in figure 4.

In confirmation of the above results, let it be stated that on June 14 a power company stopped its use of 8,000 cubic feet per second, and this caused the water in the basin to rise six inches (the diversion by the other companies and that of the Chicago canal was not arrested at the time). At the edge of the American Falls the water rose 1.2 inches.[2] At mean water much of the American Falls is scarcely more than six inches deep. With the lowering from extraordinarily high water to normal conditions, and the diversion increased in the future to 44,500 or 51,200 cubic feet per second, taken from above the Upper Rapids, the basin will be further lowered from twelve to sixteen inches or more, so that much of the rim of the basin will be exposed, and thus the flow of water will be largely cut off, not merely from the 800 feet on the eastern side of the Canadian Falls, thereby destroying that part, but also curtailing the water on the American Falls to half its present normal amount, which is only 5 per cent. of the total flow of both cataracts. This will be still further aggravated during years of low water, such as was 1901.

The preservation of the falls is now a question of inches. Under the conditions as set forth, the whole of the Horseshoe Falls will have shrunken from a crest line of 2,950 feet to 1,600 feet (including the curtailment on the Canadian side), and their diameter will have been reduced from 1,200 to 800 feet (see figure 6). They will then be

[2] It was telegraphed all over the United States that the rise was only a tenth of an inch, with congratulations of proof that no harm was being done to the falls. The term tenth-of-a-foot is one which would be used by engineers, but never in popular language, which depends upon inches. Hence the conclusion, jumped at, is partly explicable, especially by the promotion of power diversion at Niagara. But the change of depth above the Upper Rapids is that which determines the distribution and destruction of the falls. Besides, on the day of test, the discharge was 25,000 cubic feet and also nearly 18,000 more for power diversion above the normal discharge of Niagara River.

FIG. 6. NIAGARA FALLS, AMERICAN BRANCH. The half of falls on the right side of *aa* will be destroyed and that to the left damaged by full use of franchise amount.

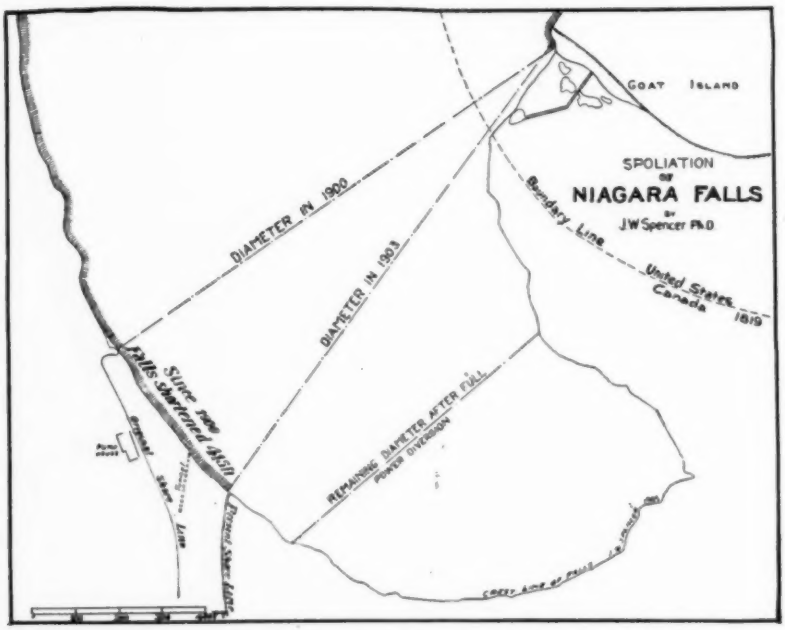


FIG. 7. MAP OF CREST LINE OF FALLS BEING SHORTENED FROM 2,950 FEET (IN 1900) TO 1,600 FEET UNDER FULL FRANCHISE DIVERSION; AND DIAMETER CURTAILED FROM 1,200 TO 800 FEET. The remaining falls will be entirely in Canadian territory.

entirely within Canadian territory, as the boundary line will become uncovered, leaving a narrow strip of rock between Goat Island and the great cataract. If the full franchise be used, the American Falls, which are 1,000 feet across, will have their southern half drained, as in figure 7, and will be further broken up into narrow sheets or strings of water.

Any attempt at restoring either the American or the eastern side of the Canadian Falls, by deepening the channels on that side of the river, would increase the velocity of the currents above and cause an extraordinary demand on Lake Erie, the result of which would be the lowering of its level at an enormous cost. The same physical changes would subsequently take place in the Huron outlet as a consequence of the lowering of the Erie level. The artificial deepening of the channel would also increase the scour, not merely of the Niagara River, but also the St. Clair channel, which lies in deposits of sand and clay.

Until such time as the use of the water shall become imperative, the preservation of the International Park and the falls is a very small bit of luxury or extravagance compared with the value and cost of great city parks, or even one of them, such as the Central Park of New York. But there is also a commercial side to this question. The yearly number of visitors to Niagara varies from 600,000 to 1,200,000 and the expenditure in transportation and at the falls is estimated as reaching sometimes $25,000,000 in a single year, giving pleasure and recreation to many people over the whole country. Are these considerations to be set aside for the gain of a few companies, or for political purposes?

A limited amount of power can be used without detriment to the scenic effects. Under the Burton act, the two New York companies are at present restricted to a developed capacity which is about half their franchises. The Ontario Company's franchise has not been restricted, although their present plant is developed to only one third its prospective size (figure 8). The full use of their allowance will affect the falls to an even greater extent than the Chicago canal, and bring into prominence the impending disasters, after the full use of the water at Chicago. The most strenuous endeavors are being made to extend the spoliation of the falls to its utmost limit, and recently the Ontario Company has sought permission to harness even the Whirlpool Rapids, which are fifty-one feet in height and only a little less imposing than the falls themselves. This company desires to obtain from twenty to twenty-five per cent. of the flow of the river, or nearly 400,000 gross horse-power, besides the privilege of disfiguring the gorge by their structures, such as the one already placed below the falls, though this at present is only one third of its prospective size, as shown in figure 8. There are two other great power houses in the Canadian Park. Those

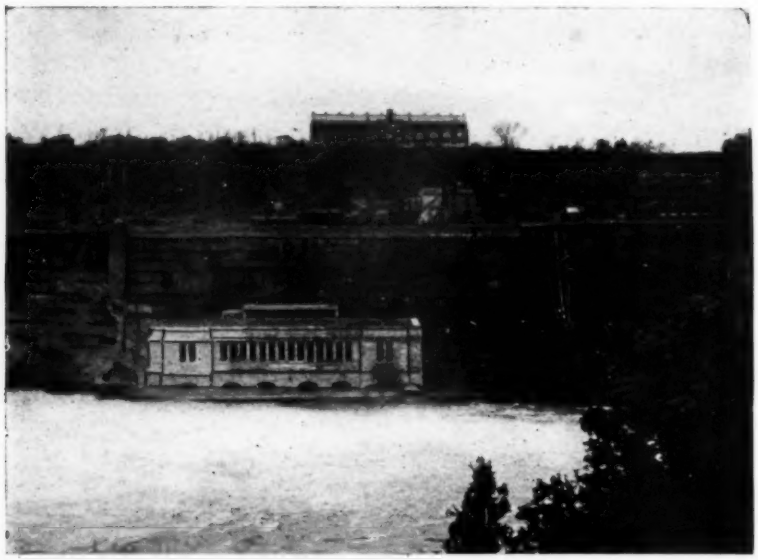


FIG. 8. ONTARIO COMPANY'S POWER HOUSE (270 FEET LONG) IMMEDIATELY BELOW THE FALLS IN THE CANADIAN PARK. This is only a third of the proposed length; even at present it is a most striking obstruction of the gorge, as seen from the New York side.

on the New York side are not in the park and can not be seen from the falls, but the eastern banks of the river below the park are crowded with works.

18. *Effects on Navigation.*—The canals and harbors are much shallower than they used to be. Several inches of this are due to the power diversion, which, however, is not at present seen, owing to very high water. The lowering of the level of the basin above the Upper Rapids, increasing the slope of the river, and consequently the velocity of the current, also lowers the level of the lake above. An increased discharge of 22,000 cubic feet per second lowers Lake Erie by one foot. On the large steamers in the carrying trade, each inch of draft represents a return of $100 in extra freight receipts. The canals and harbors should not be reduced in depth by power diversions at a time when there is a clamor for deeper channels. The impairing of navigation, under conditions as shown above, threatens to reach two, or even two and a half feet. Under the estimate made for the American Section of the International Commission, the cost of repairing the damage caused by the Chicago drainage canal was found to exceed $12,000,000, so that the total costs to both countries on account of power diversion promises to reach twenty-five millions of dollars or more. Are the power companies willing to pay for their share of this costly franchise, and for the loss owing to the diminished business going to and at the falls, which may reach $25,000,000 a year?

Unfortunately in the Province of Ontario it has become a political question, and there the government has adopted the Power Company which is causing the greatest amount of damage, although they could have obtained their supply from two other companies which are doing relatively little harm.

A prominent man at Niagara Falls, N. Y., has expressed himself as follows: "The subject of the diversion for power purposes is a burning question here, and a great number of unreliable and misleading statements have been made by interested parties to justify the diversion, stating that no damage will be done, and the work of Spencer" (referring to my recent book on the Falls of Niagara[3]) "is most timely in giving the results of a scientific examination of the whole problem, with the data on which the conclusions are based." In that work, the data are brought down only to January, 1906, but this contribution is based upon additional information extended to the present day, enabling me to give fuller and more precise results than in the original work.

The preservation of the falls now depends upon the governments at Washington and Ottawa. In the United States, apart from those interested in the diversion of the water, there is a wide-spread sentiment in favor of saving the scenic wonders of Niagara. But now another interest joins hands with this, which is economic and of great magnitude, namely, the protection of navigation. It is to be hoped that the national governments will so control the matter that this unique world-treasure will be preserved for all time.

At the present time the commission recommends the use of 28,500 cubic feet per second for the two restricted American power companies and for the Chicago drainage canal, while 36,000 cubic feet per second are conceded to Canada.

[3] "The Falls of Niagara," by J. W. Spencer, Geological Survey of Canada, 1907.

THE INDUSTRIES OF NIAGARA FALLS

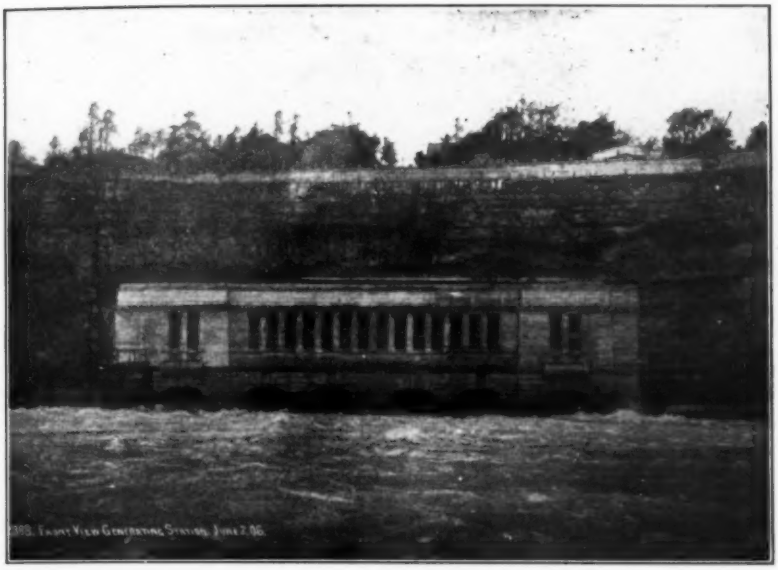
By RAYMOND H. ARNOT
ROCHESTER, N. Y.

NOTWITHSTANDING the fact that the Niagara Falls region is chiefly celebrated by reason of its natural wonders, intelligent people are gradually coming to understand that here are to be found engineering works in the form of electrical-power development plants which are unrivaled anywhere in the world, and electrochemical industries which are likely to grow of greater importance with increasing knowledge of the electrochemical art.

When ground was broken in 1890 for the installation of the first great power plant at Niagara Falls, the engineers in charge of the project regarded the development of even fifteen thousand horse-power of electrical current with grave concern because at that time economical transmission of electricity over long distances was deemed hardly practicable and because the possibilities in the field of electrochemistry had been to only a slight extent foreseen. Except in the minds of a few, therefore, the utilization of any large amount of water from the Niagara River for the generation of power was held to be an undertaking of doubtful wisdom at best.

However, within a comparatively short time after the determina-

ONTARIO POWER COMPANY, NIAGARA FALLS, ONTARIO.



ONTARIO POWER COMPANY, NIAGARA FALLS, ONTARIO.

tion of engineers to install a large generator plant at Niagara Falls, discoveries were announced in the field of electrochemistry which if extensively developed would require the use of thousands of horse-power of electrical energy, and these discoveries encouraged the promoters of the great power project to believe that capital invested in the proposed plant would not be spent in vain. Moreover, the perfecting of an economical system of transmitting the electric current over considerable distances made it evident to engineers that very large quantities of Niagara power could be utilized commercially beyond the immediate vicinity of the power plants.

Two of the great power houses have been erected on the American side of the Niagara River somewhat over a mile from the crest of the cataract. In order to take advantage of the potential energy of the water and to afford an outlet for the water after its pressure has been used, two wheelpits were excavated out of solid limestone and shale about 177 feet deep, 18 feet wide and 450 feet long. Over each of these wheelpits was constructed a massive power house to contain the generators, switchboards, oil switches and other necessary apparatus. Extending vertically down the wheelpits to the depth of about 140 feet are hollow shafts to connect the generators on the power house floor with the turbines or water wheels below. Running parallel with each of the ten or eleven shafts in each power house is an immense pipe, or penstock as it is technically termed, of seven and one half feet in diameter through which water, after proper screening to remove ice and other obstructions, is conveyed from the intake canal to each turbine. After the large volume of water conveyed to

each turbine, under an effective head of about 140 feet, dashes against the turbine blades, the water is disgorged into a subterranean tunnel about 21 feet in height and over a mile in length, through which the discharged water is conducted to the lower Niagara River, just below the abutment of the upper steel arch bridge.

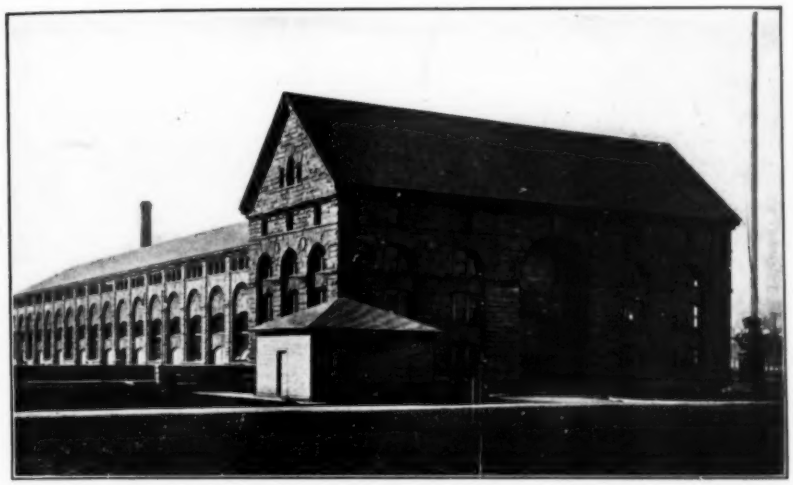
The turbines, by means of the shaft connection, cause the generators on the power-house floor to revolve at the rate of 250 revolutions a minute and to develop a two-phase alternating current of 5,000 horse-power.

Each generator with its connected turbine is entirely distinct from the other generators and turbines, and can be stopped by shutting off the water from the supplying penstock and by applying electrically operated brakes.

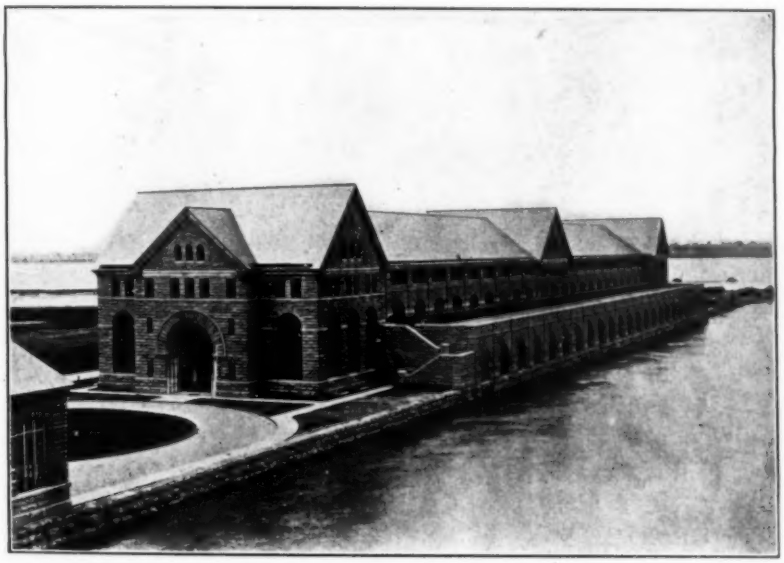
Practically, the whole tremendous weight of each generator, shaft and turbine is sustained by the hydrostatic upward pressure of water conveyed in separate pipes from the level of the intake canal to a compartment of the turbine wheel-case where the water presses against the lower surface of a disc secured to the shaft.

To generate an electric current by dynamos a coil of wire must cut the lines of magnetic force emanating from a magnetic field. It is immaterial whether the coils of wire (or armature) revolve around the magnetic field or the magnetic field revolves around the armature. For mechanical reasons, however, all the great generators at Niagara Falls are constructed so that their magnetic fields shall revolve about the coils of wire (the armature).

After the generators have developed the electrical energy the current controlled by appropriate switching devices is transmitted to the power tenants in the immediate vicinity and to the more distant tenants in Buffalo, Lockport and elsewhere. Where power is delivered to tenants within a short radius of the power plants, the current is transmitted at the generator voltage, but where power tenants are situated at such distances from the generators that electric current could be transmitted only at considerable loss at the generator voltage, it becomes necessary for economical transmission to increase or "step up" the voltage of the current by passing the electrical flow through transformers. A transformer by means of primary and secondary coils of wire of different diameters wound around a laminated iron core and with windings in a fixed ratio to each other may increase or diminish the voltage of a current according as an increase or a diminution of voltage may be necessary. The voltage of the current delivered in Buffalo is about 22,000, but as it would be obviously impossible to utilize so great a current pressure the electricity in Buffalo again passes through transformers where the voltage of the current is reduced to that required in the electric light and electric car service and for other power purposes.



POWER HOUSE NO. 1, NIAGARA FALLS POWER COMPANY (American side).



POWER HOUSE NO. 2, NIAGARA FALLS POWER COMPANY (American side).

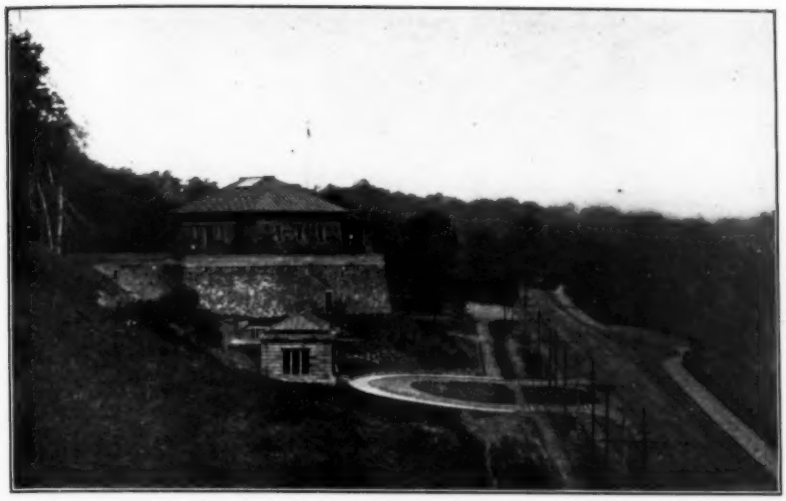
On the Canadian side of the Niagara River are three great power plants which are now generating about 160,000 horse-power, but which will ultimately develop nearly 400,000 horse-power. The Canadian generators are of much greater capacity than those on the American side and develop from 10,000 to 12,500 horse-power each. Two of these plants are built over wheelpits like those described on the American side and one of the companies in order to release the water used in its turbines has constructed *under* the Niagara River a tail race tunnel, the portal of which discharges directly beneath the Horse Shoe Falls.

The Ontario Power Company by erecting a power-house at the level of the lower river and near the foot of the Horse Shoe Falls and by

CANADIAN NIAGARA POWER COMPANY'S POWER HOUSE.

conveying water through an eighteen-foot conduit from an intake canal above the falls has obviated the necessity and the great expense of building a wheelpit for the utilization of the water pressure and has acquired for its turbines practically the full head of water between the upper and lower rivers, a difference in level of approximately 175 feet.

Directly above the Ontario Company's power-house the great eighteen-foot conduit is tapped by penstocks nine feet in diameter which convey the rushing water to the blades of the turbines. The generator attached to each turbine is thereby caused to revolve at the rate of 187½ revolutions a minute. Each generator weighs 231 tons and develops an alternating current of 10,000 to 12,000 horse-power at 12,000 volts, much of which is transformed to a voltage of 60,000 and transmitted with comparatively small loss over aluminum cables to Rochester, Auburn and Syracuse, a maximum distance of 160 miles.

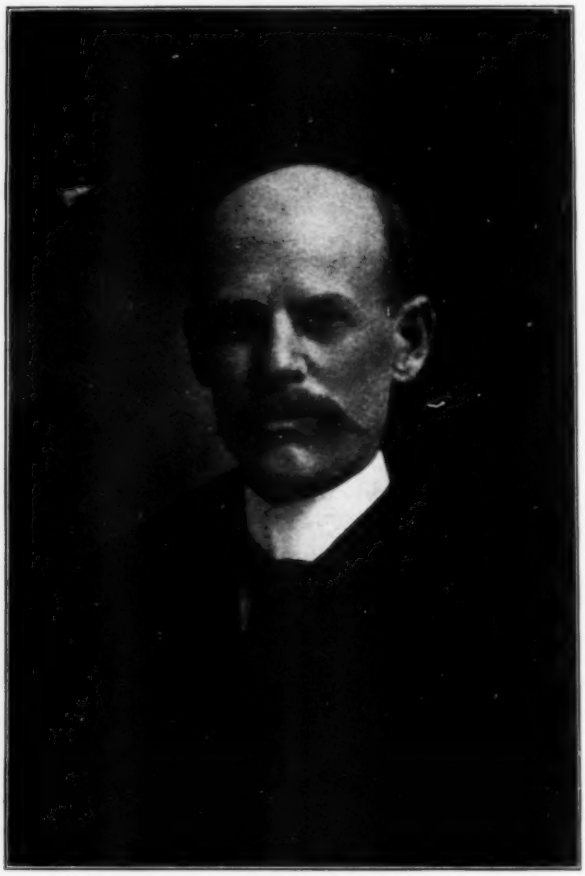


ENTRANCE AND SPILLWAY HOUSE, ONTARIO POWER COMPANY, NIAGARA FALLS, ONTARIO.

The uses to which electrical power is put in the city of Niagara Falls are most interesting. In 1886 Charles M. Hall, at the age of twenty-two and fresh from Oberlin College, devised a process for the inexpensive production of aluminum. Prior to Mr. Hall's discovery aluminum though the most abundant of all metals was united to other elements in such a way that a separation of the metal from its compounds was very difficult and correspondingly expensive.

Mr. Hall's process for obtaining aluminum from its ore is a reduction or deoxidation process by electrolysis. Into a carbon lined vat or "reducing pot" extend carbon cylinders. The vat is partly filled with powdered cryolite, a beautiful white mineral mined in southern Greenland. When the electric current passes, the resistance

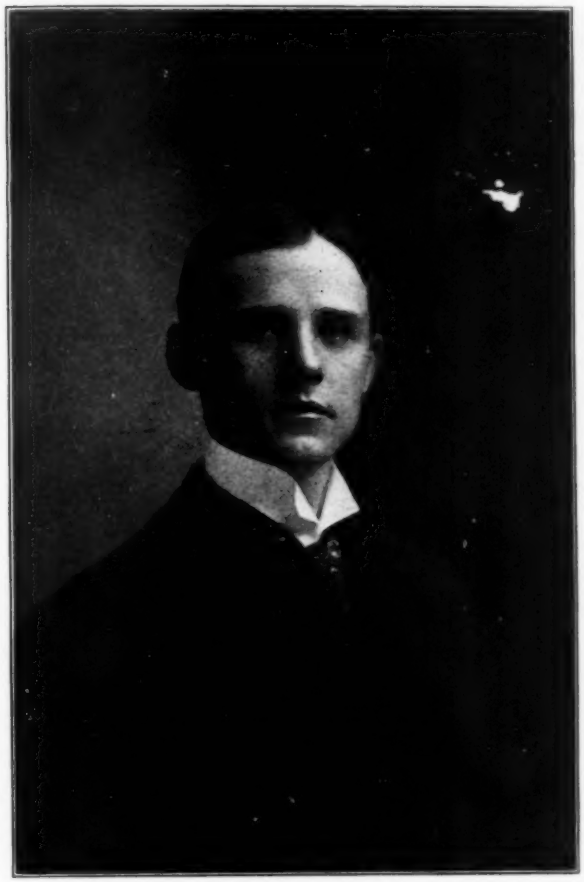
POWER HOUSE NO. 1 AND POWER HOUSE NO. 2 AND "STEP UP" TRANSFORMER HOUSE IN MIDDLE, NIAGARA FALLS POWER COMPANY (American side).



EDWARD G. ACHESON,
Discoverer of Carborundum, Artificial Graphite and Siloxicon.

to the passage of the current offered by the cryolite transforms into heat sufficient electrical energy to fuse the cryolite. Into the fused cryolite is poured calcined and purified bauxite in powdered form. The oxygen of the purified bauxite combines with the carbon of the anodes or positive poles of the electrolytic cell to form carbon monoxide and carbon dioxide gases and the aluminum is withdrawn in an almost chemically pure state. Since the cryolite serves merely as a solvent for the bauxite from which the aluminum is obtained and is unaffected by the electric current, the reduction of bauxite is continued indefinitely by pouring into the reducing pot enough bauxite to supply the place of that reduced.

Another electrolytic process in use at Niagara Falls is the production of caustic soda. The demand for caustic soda in many industries such as soap-making and paper-making is so great that an inexpensive way of producing this important alkali is imperative. The process is

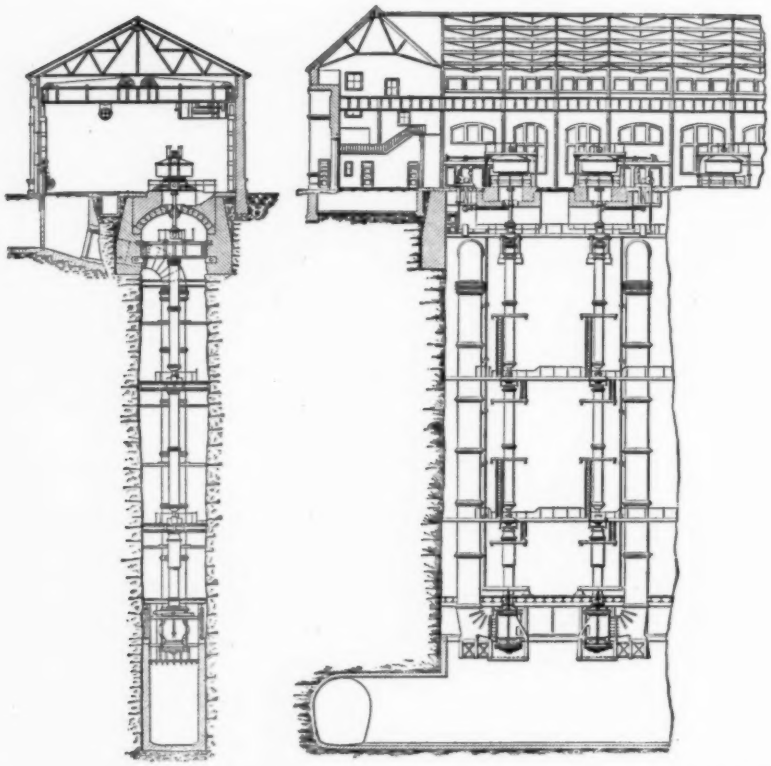


CHARLES MARTIN HALL,
Inventor of the Electrolytic Process for reducing Aluminum Ore.

comparatively simple. Into an electrolytic cell is poured common salt in solution. When the electric current passes through the brine the salt is separated into its constituent elements, chlorine gas and the metal sodium. The chlorine gas is evolved at the anodes of the cell and being led off combines with slacked lime to form chloride of lime or bleaching powder. The sodium unites or reacts with water to form sodium hydroxide or caustic soda.

When Moissan, the great French chemist, perfected the electric furnace he gave to scientists an easy way of producing a temperature which far exceeds that of ordinary fuel and even that of the oxy-hydrogen flame, and which made possible new and useful combinations and dissociations of matter obtainable in no other way than by the use of intense heat. The electric furnace is used at Niagara Falls in the manufacture of several new and important products.

Among the many recent discoveries in the field of electrochemistry

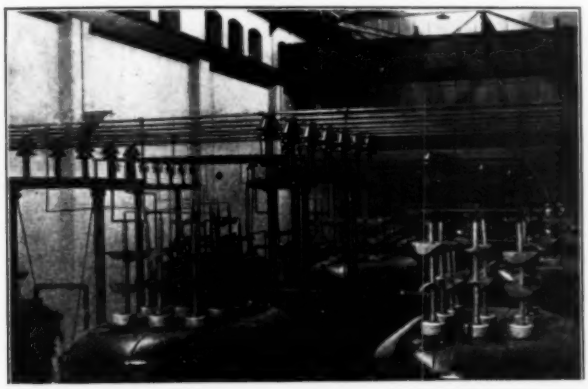


LONGITUDINAL AND TRANSVERSE VIEWS OF POWER HOUSES, showing wheelpits, generators, shafts, turbines, penstocks and discharge tunnels.

that of carborundum in 1891 by Mr. Edward G. Acheson is of great practical value. This new product is made by chemically combining in the intense heat of an electric furnace of the resistance type common sand and ground coke. After the charge has remained in the furnace for about thirty-six hours in a temperature of over 7,000° Fahrenheit, the resulting combination is found in a beautiful crystalline form. Carborundum ranks next to the diamond in hardness and is therefore used as an abrasive. In its so-called amorphous form it is used as a substance of great refractory power.

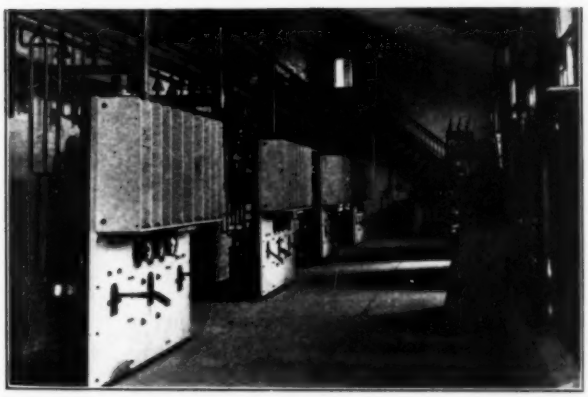
Metallic silicon, which is largely used in the steel industry to absorb the gases of the molten steel, is made at Niagara Falls by a deoxidation or reduction process. Ordinary sand and ground coke are intimately mixed and subjected to the heat of an electric furnace. The carbon combining with the oxygen of the sand is evolved as carbon monoxide gas; the residue is the element silicon in almost chemically pure condition.

Another of Mr. Acheson's useful discoveries is the production of graphite by artificial means. Graphite is carbon, but not the only form of carbon. Carbon exists in the amorphous form as in coal,



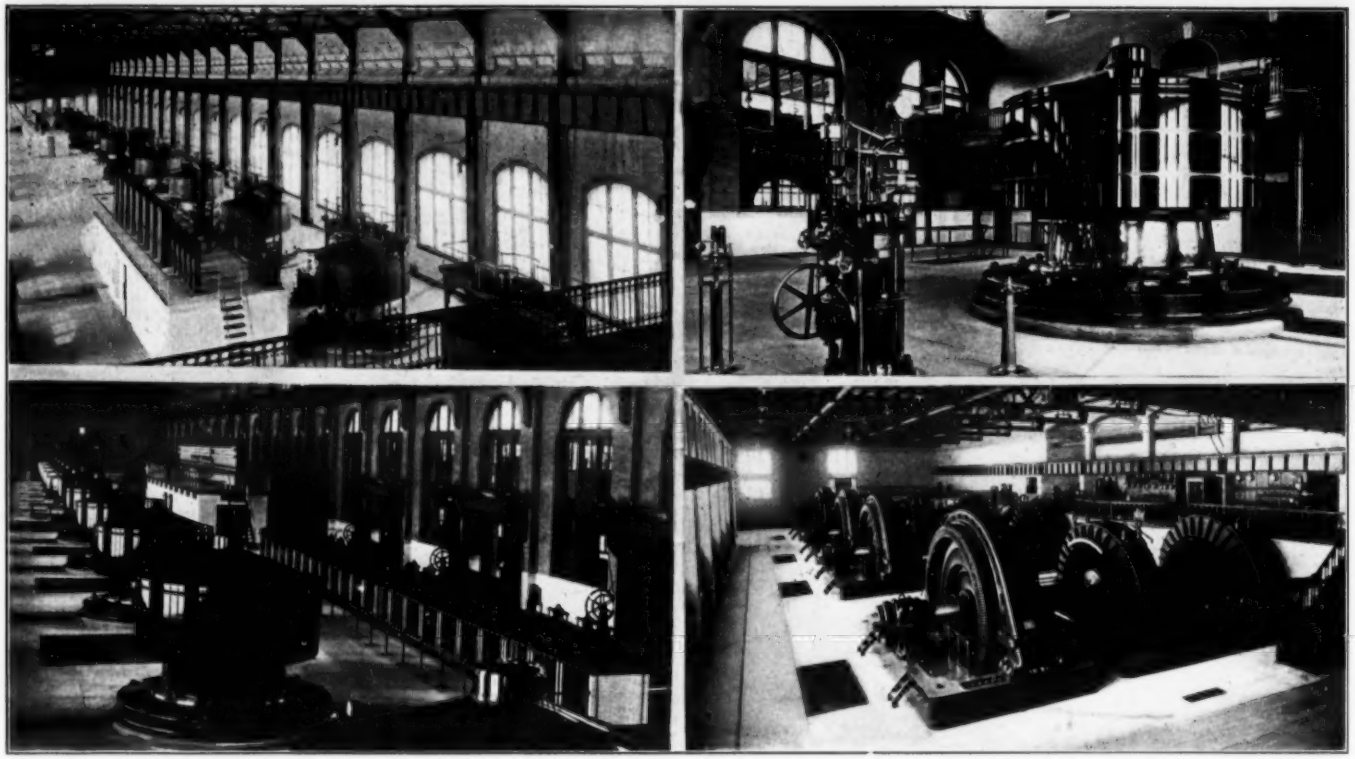
"STEP UP" TRANSFORMER PLANT OF CANADIAN NIAGARA POWER COMPANY.

TRANSFORMER PLANT OF NIAGARA FALLS POWER COMPANY.



11,000-VOLT SWITCHBOARD AND BARS IN "STEP UP" TRANSFORMER, plant of Canadian Niagara Falls Power Company.

charcoal and lampblack; in the crystallized form as diamond, and in the graphitic form as graphite. Until the discovery of a process for making graphite out of amorphous carbon the only source of supply



INTERIOR POWER HOUSE No. 1, NIAGARA FALLS POWER COMPANY (American side).
INTERIOR OF POWER HOUSE No. 2, NIAGARA FALLS POWER COMPANY (American side).

GENERATOR AND GOVERNOR (oil pressure operation). Niagara Falls Power Company (American side).
INTERIOR POWER HOUSE, ONTARIO POWER COMPANY, NIAGARA FALLS, ONTARIO, showing ten and twelve thousand horse power generators and double turbines.

lay in graphite mines such as those in the United States, England and Ceylon.

Artificial graphite is now made from any amorphous carbon which contains an admixture of some carbide forming substance and though other carbonaceous substances are used anthracite coal has been found to be the most satisfactory and economical carbonaceous material from which to make graphite.

Graphite is made by heating anthracite coal to a very high temperature, approximating 7,500° Fahrenheit. Into a long fire brick furnace is placed anthracite coal and through it a carbon rod passes. The heat generated by the resisted passage of the electric current through the charge is so great that practically all the impurities of the coal are volatilized, leaving its carbon content in the graphitic form.

Mr. Acheson has lately perfected a process whereby artificial graphite can be treated with gallotannic acid in such a way as to produce graphite so fine that it is well nigh molecular.

In the year 1892 it was accidentally discovered that if ordinary quicklime and coke were fused together, the resulting chemical combination would, by the addition of water, produce an illuminating gas of great brilliancy. The gas formed in this peculiar way is acetylene gas and the material from which it is generated is calcium carbide.

Calcium carbide is made at Niagara Falls by placing an intimate mixture of about three parts of powdered quicklime to two parts of powdered coke into an electric furnace of the so-called arc type. The current of electricity generates an intense heat which chemically combines the calcium of the quicklime with the carbon of the coke, the oxygen of the quicklime uniting with some of the carbon to form carbon monoxide gas which escapes.

It is interesting to know that the discovery of calcium carbide was almost simultaneously announced by two independent workers in electrochemistry, Moissan, the great French chemist, and Thomas L.

EIGHTEEN-FOOT CONDUIT, ONTARIO POWER COMPANY, NIAGARA FALLS, ONTARIO.

Willson, an American. Willson's discovery of calcium carbide, however, antedated Moissan's announcement by about six months.

At Niagara Falls are also to be found an immense paper mill which produces annually thousands of tons of newspaper made from

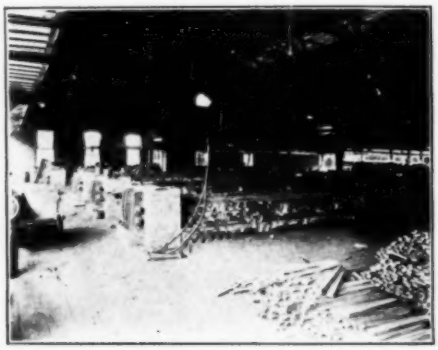
CARBORUNDUM FURNACE WITH CHARGE READY FOR HEATING.

CARBORUNDUM FURNACE WHILE CHARGE IS BEING HEATED, showing carbon monoxide gas issuing from side of furnace.

spruce logs reduced to the proper consistency by the mechanical and the chemical or sulphite process, a plant where lead is economically separated from its ore by electrolysis, a laboratory where vanilla and other natural extracts are successfully prepared by synthetic chemistry, and furnaces where bauxite is crystallized into an extremely hard substance for abrasive purposes.

From the foregoing survey of some of the industrial enterprises at

CARBORUNDUM FURNACE WITH WALLS REMOVED AFTER HEATING, showing blocks of crystalline carborundum.



ELECTRIC FURNACES OF THE RESISTANCE TYPE IN WHICH ARTIFICIAL GRAPHITE IS MADE.

Niagara Falls it is evident that that region is a very important electric and electrochemical center and that it is destined to increase in importance with every new discovery in the electrochemical art.

THE CLASSIFICATION OF MATHEMATICS

By Professor G. A. MILLER
UNIVERSITY OF ILLINOIS

HERR VALENTIN, of Berlin, who has been working on a general mathematical bibliography for more than twenty years, estimates that the total number of different mathematical works is about 35,000 and that about 95,000 mathematical articles have appeared in the various periodicals.[1] The present rate of growth of this literature is so rapid that, without increasing the amount per year, the next fifty years would produce more than the total produced from the earliest records to the present time. Without some means of classification this vast store of knowledge would have little value from the difficulty of finding what is wanted. Before entering upon a description of any details of classification I shall make a few remarks on some of the terms of classification which are familiar to all; viz., arithmetic, algebra and geometry.

About three years ago Sir Oliver Lodge published an unusual work under the unusual title "Easy mathematics, chiefly arithmetic, being a collection of hints to teachers, parents, self-taught students, and adults; and containing a summary or indication of most things in elementary mathematics useful to be known." This title is followed by a no less unusual preface, whose tenor may be inferred from the following quotation: "The mathematical ignorance of the average educated person has always been complete and shameless, and recently I have become so impressed with the unedifying character of much of the arithmetical teaching to which ordinary children are liable to be exposed that I have ceased to wonder at the widespread ignorance, and have felt impelled to try and take some step towards supplying a remedy." The main reason for referring to this work in this connection is to call attention to what appears to be a very common use of the word arithmetic, as including most but not all of the mathematics which the average educated man should know.

Efforts to arrive at a much more accurate definition of the term arithmetic are apt to meet with disappointment. On the one hand, we meet with contradictory classifications among works of the highest authority. The great mathematical encyclopedia which is being published almost simultaneously in German and French includes determinants under arithmetic, while the *International catalogue of scientific*

[1] Felix Mueller, *Bibliotheca Mathematica*, Vol. 7 (1907), p. 416.

literature places determinants under algebra. If one were inclined to adopt the common definition that *arithmetic is the science of the relations existing between numbers,* one would be perplexed by the fact that the theory of groups of finite order is classed with arithmetic in the encyclopedia mentioned above, while it might be difficult to name any other mathematical subject which makes less direct use of numbers than this theory does.

Although these conflicting uses of the term arithmetic preclude the possibility of formulating a definition which is in accord with the usage of all of the prominent mathematicians, yet this term presents very much less serious difficulties than that of algebra from the standpoint of giving an acceptable definition. All are agreed that the four fundamental operations with natural numbers constitute a part of arithmetic. In fact, all that is generally studied in the elementary schools under the title of arithmetic is now universally regarded as a part of this subject, even if the Greeks called it logistica and dignified what is now generally known as higher arithmetic, or number theory, by the term arithmetic. While it might be difficult to find anything which was included under the term arithmetic during the entire historic period of mathematics, it is not difficult to find things which are now universally accepted as parts of this subject.

When we come to the term algebra, on the contrary, it seems impossible to find any common ground. If we think of algebra as a generalized arithmetic in which numbers are replaced by symbols which may have any numerical value, we are perplexed by such statements as "In arithmetic it is customary to represent any number whatever by a letter, it being understood that this letter represents the same number as long as the same subject is under consideration."[2] On the other hand, if one were inclined to consider the elements of the theory of equations as the peculiar sphere of algebra, the recent standard encyclopedia of elementary mathematics by Weber and Wellstein,[3] in which simple and quadratic equations are classed under arithmetic, would imply that such usage was not universal among eminent authorities.

Coming to the term geometry, we encounter scarcely less trouble. On the one hand, we find it advocated that geometry should be recognized as a science independent of mathematics, just as psychology is gradually being recognized as an independent science and not as a branch of philosophy,[4] while, on the other, we find that the Paris Academy of Sciences uses the term geometry as a synonym for pure mathematics. In the one case, the term geometry is used for what is

[2] "Encyclopédie des sciences mathématiques" (1904), p. 22.

[3] Published by B. G. Teubner, Leipzig, Germany.

[4] Bôcher, *Bulletin of the American Mathematical Society,* Vol. 11 (1904), p. 124.

not regarded as mathematics, and, in the other, it is supposed to comprise all that is generally included under the term mathematics. With such a wide range of usage among eminent authorities it is evident that an acceptable definition is hopeless.

These instances appear sufficient to emphasize the fact that the terms arithmetic, algebra and geometry have no definite meanings in mathematical literature. They may be compared with the names of the constellations, which attract the attention of the amateur but are not generally taken very seriously by the professional astronomer since their boundaries are not defined with clearness. Just as it may be difficult to establish a connection between the figures represented by the names of some of the constellations and the arrangement of the brighter stars in them, so it is difficult to see much connection between the meaning of the terms arithmetic, algebra and geometry, and some of the subjects classed under these heads. In a growing science it is very desirable to have some elastic terms—terms to which we assign broader and perhaps even different meanings as our knowledge advances. In fact, the term mathematics is itself preeminently one whose meaning is a matter of slow development, even if we accept such brief definitions as *mathematics is the science of saving thought,* or "mathematics is the science of drawing necessary conclusions."

The fact that many things which appear unrelated when studied superficially exhibit the most intimate connections when viewed from a higher standpoint has doubtless been a potent cause of the variety of usage as regards general terms of classification. There are no natural lines of division in mathematics. In fact, one of the most attractive phases in the development of mathematics is the discovery of the relations existing between what was supposed to be unrelated. In other words, the unifying of mathematical truths is one of the chief concerns of many of the workers in this domain. Although the elements of arithmetic, algebra and geometry appear sufficiently distinct to the beginner, the marks of distinction vanish one by one as one proceeds in following up the ideas starting from these centers, as is evidenced by the term analytic geometry, since analysis and algebra were synonyms for Newton, Euler and Lagrange.

Notwithstanding the fact that there are no natural lines of division in mathematics, classification is essential and need not be entirely artificial; for, marks of differences which are only superficial are, nevertheless, worthy of note and frequently furnish convenient centers for groups of very closely related ideas. Both subject-matter and method offer many such superficial marks of difference which are utilized for the sake of classification. As we go away from these centers we naturally reach facts which seem equally closely related to more than one center, and in such cases it is necessary to have either

a duplicate or an artificial classification. For some purposes, such as arranging books on shelves in a library, the former is not feasible, and hence arises the constant opportunity of complaint on the part of those who use libraries with a view to obtain all available facts along certain lines. This opportunity is inherent in the subject and hence must exist under the most ideal conditions, but it is sometimes made more apparent by the fact that books are not always classified by those who are as familiar with the subject-matter as their authors were at the time of writing.

Although the present active period in mathematical development has exhibited many relations between subjects which appeared to be unrelated, yet it has been still richer in exhibiting new centers of developments which promise to be useful, and hence it has called for a great extension of classification headings, as may be seen from the 1908 edition of *l'Index du répertoire bibliographique des sciences mathématiques*. In order that a method of classification should give promise of usefulness for a long period of time, it must therefore be so constructed as to admit readily of indefinite extensions. This is a characteristic property of the two important methods of classification which have been adopted after international conferences, viz., *l'Index du répertoire* just mentioned and the International Catalogue mentioned above. The former of these provides for an indefinite extension of its fundamental headings by using the capital letters of the Roman alphabet with various exponents to represent these headings. On the other hand, the International Catalogue divides all mathematics into four parts, in addition to a general heading for history, periodical, general treatises, etc.

In the first five annual issues of the International Catalogue these four parts into which all mathematics is divided bore the following headings: Fundamental notions, algebra and theory of numbers, analysis, and geometry. In the last issue of this catalogue the first of these headings is replaced by arithmetic and algebra, in accordance with the decision of the international convention of 1905. The term algebra now appears in two of the four headings, and, if it is remembered that the theory of numbers is higher arithmetic, this term is implicitly in two of these four headings. This is another evidence of the vagueness of the terms arithmetic and algebra as used in some of the best mathematical literature of the present day, and seems to imply that these terms, especially the former, are more and more devoted to those fundamental notions which are most prominent in the later developments, or have the most frequent uses in related sciences. As the science grows some things which are now classed with analysis or geometry will naturally be put under other headings.

While it might be impossible to advance good reasons for dividing

mathematics into exactly four grand divisions, yet a small number of divisions offers advantages by furnishing names which will generally be remembered and by emphasizing the connection between extensive developments. It is true that the names of these grand divisions do not have a very definite meaning, but they have some meaning, and they exhibit something of the tenor of the various branches whose names are too numerous and appear too erudite to the average educated man. Instead of simply saying that one is working on Ausdehnungslehre it may be some satisfaction to add for the benefit of the uninitiated that this is a kind of algebra, and thus established language contact even if thought contact is out of question.

A question of more general interest is the number of parts into which mathematics is divided in the final classifications. The answer to this question gives some idea of the fractional part of the entire literature which must be examined by one who is seeking all that is known along a particular line. The last issue of the International Catalogue contains only about two hundred headings, so that one would have to look over one two-hundredth of the total publications of the year in order to find all that had been written during the year on a subject comprised under a single heading. In this respect *l'Index du répertoire* is much superior. In fact, the last number of the *Revue semestrielle des publications mathématiques,* which follows this index, classifies the publications under about seven hundred headings, and, as a large number of headings have no entries during one of the periods of six months, it would frequently be possible to get at all the literature which appeared on a particular subject during a period of years by examining less than a thousandth part of the total mathematical literature of the period.

The preceding paragraph relates to the classification of current literature. The classification of the total literature is in a much less satisfactory condition. The magnitude of this work may be inferred from the facts that Müller's *Mathematisches Vocabularium* contains more than ten thousand technical terms used in pure and applied mathematics and that it is not exhaustive. As most of these terms relate to concepts which either are or may become the centers of a series of closely related developments, we can predict no limit to the number of headings under which the mathematics of the future will be treated. In fact, if we adopt the view that mathematics consists of creations as well as of discoveries, considerations as to limits become very vague even if they do not lack interest.

Professor Sylvester once called himself the mathematical Adam in the proud consciousness of having named a large number of algebraic concepts and that these names had become more or less current among his colleagues. While technical terms are useful for the sake of classi-

fication yet the number of such terms may become so large as to justify the criticism of Hankel that the stately mathematical structure resembled the tower of Babel. The proper time for the introduction of new technical terms and new heads of classification must depend upon the good judgment of the workers in this field, it being remembered that terms and classifications are secondary matters, although by no means useless, and that the main thing is to extend the domain of knowledge, especially where the beauty or usefulness of the results assure them a permanent place in the intellectual wealth of the world.

A large variety of classifications may prove serviceable to the investigator. Sometimes an author's catalogue may render the best service, while at another the grouping together of a large number of related things as is done in the *Jahrbuch über die Fortschritte der Mathematik*, where pure mathematics is divided into only fifty parts, renders the most valuable service. At still another time, the dictionary arrangement under thousands of terms, as it appears in the indexes of large works, especially in the incomplete encyclopedia to which we referred above, offers the most convenient method of arriving at the desired information. Fortunately the current mathematical literature is now being classified according to several different methods, each possessing peculiar advantages for the different needs of the scholar.

The history of classification in mathematics is very old as may be seen from the fact that the mathematical handbook of Ahmes, which was written about 1700 B. C., already contains the divisions into arithmetic, and plane and solid geometry. As this work bears the title "Directions for obtaining a knowledge of all dark things," it would appear that the observance of the distinction between arithmetic and geometry may have been older than of that which separates mathematics from the other sciences. In fact, even at the time of Plato, the term mathematics included all scientific instruction and its more restrictive meaning seems to have had its origin in the Peripatetic School. The main divisions of the mathematical sciences during the Greek period were: logistica, arithmetic, plane and solid geometry, music and astronomy. One of the best known classifications of mathematics is the Quadrivium of Boethins, viz., arithmetic, music, geometry and astronomy; and it is an interesting coincidence that the International Catalogue should have established a quadrivium of pure mathematics, as was observed above.

Among the general terms of classification, that of analysis is probably the least familiar to the non-mathematician. All have some idea of arithmetic, algebra and geometry from the context of elementary text-books bearing these names, but it is not customary to place the term analysis on the cover of an elementary text-book in the English language. Perhaps this is due, in part, to the fact that our secondary

mathematics does not generally involve the concept of derivative, which was introduced into French secondary instruction in 1902, and has proved successful in that country as well as in some others where it has been tried. From a historical point of view analysis is merely an extension of algebra. It has already been observed that for Newton, Euler and Lagrange analysis and algebra were synonyms, and the present significance of the term analysis may be inferred from the fact that the most familiar subjects that are now generally comprised under it are differential and integral calculus and the theory of functions.

It may be desirable to add that the aim of the present article was to convey some idea of the extent and nature of the modern mathematical developments, from the standpoint of classification. While this standpoint reveals only the outside yet this side is worth knowing and is apt to awaken some thoughts in regard to what may be within. As the use of machines has revolutionized the material world, so the use of mathematics has revolutionized the efficiency of thought in regard to problems whose solution is sufficiently elementary to come under known developments. As these developments proceed they provide for greater efficiency and wider applications. The analogy between mathematics as a machine of thought and an ordinary labor saving device known as a machine can be traced through many points of interest. It should, however, be emphasized that the real mathematician is the inventor of such machines, but not the machine itself.

ACADEMIC ASPECTS OF ADMINISTRATION[1]

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THE community of spirit that animates such occasions as this is an interest in the academic life—a conviction, studied or casual, sincere or perfunctory, that much of what makes life worthy has its source here. What more appropriate than to discuss the *status quo*, with a view to discover what forces are making for and what against the vital concerns of academic welfare?

Psychologically, I can not endorse the platitude that silence means consent. As I have tried to interpret this eloquent if enigmatic expression, it has appeared to mean complacency, even indifference; it means hesitation and timidity; it means expediency and temporizing; it means torpidity or denseness of understanding. Hence the way of the reformer is hard. It is upon that ill-paved road that I am to venture, and with no other warrant than a common interest, to invite companionship.

The general silence in the academic ranks is hardly a convincing proof that all's well; nor is the silence wholly unbroken. The literature of protest is growing; and the murmur of discontent may be plainly heard by the sympathetically attuned ear. To appreciate the atmospheric conditions that prevail in the academic grove and that at times impress and oppress the dwellers therein with the suspicion that they have inherited a vale of tears with a bad climate, requires some familiarity with the general features of the habitat. To begin with, the grove itself is no longer the peaceful retreat amid cloistered walls and quiet walks, to which the bookish fancy of the uninitiated and the impervious imagination of the reporter are so fondly attached. The trolley clangs by its portals; the noise and dust of the city pervade its corridors; the unhedged campus is criss-crossed by throngs of eager invaders seeking a short-cut to learning. The guileless, absent-minded, root-grubbing professor, absorbed in profitless didactics, survives only in those lingering echoes of receding ages—the comic papers. The American professor desires to live in the world and to assume responsibilities and privileges according to his capacity. He cherishes ideals not of scholarship alone, but of service—worthy, dignified, and by higher standards profoundly useful. Compositely

[1] An address at the Collegiate Conference in connection with the seventy-fifth anniversary of Oberlin College, June 24, 1908.

(I ignore the pardonable exception of those still overawed by their own doctor's dissertations), he entertains no illusion that the fate of culture rests in his hands. He recognizes the many forces that sympathetically with his own endeavors are making for a common goal. He recognizes with deep concern the many other groups of influences that display the lure of cheap success, that crowd out the nobler, calmer virtues by an insistent demand for immediate returns, and bring the money-changers back into the temple of learning. Thus coming to his own, looking backward for the benefit of experience, looking inward for the illumination of what might be, he is emboldened at times to look forward to a future in which shall be more freely realized the career that he cherishes, to a release in greater measure from the hampering restrictions amid which he has become resigned to adjust his own service.

A sensitive barometer of the academic atmosphere is to be found in what we have learned from the Germans to call *Lehrfreiheit;* but which as made in Germany is by no means a cheap article or easy to secure. This delicate instrument must be adjusted to each climate; and to read its indications is something of an art. The facetiously inclined like to repeat the dictum that Boston is not a city, but a state of mind; but so is every locality with a title to distinction. America is a state of mind; the university reflects, fosters and imbibes states of mind. The state of mind marked on the intellectual map as academic freedom is difficult to localize. One is tempted to say that it is bounded on the north by the overshadowing mountains of the check-book, on the east by the tidal waves of current opinion, on the south by the chain-and-compass survey of past generations, on the west by the undrained marshes of political venture. Its contours are evasive and shifting. It is best recognized by the cultures it favors and by the serenity and charm of its landscape. The condition it implies is much more than the untrammeled freedom to teach fearlessly what reason finds true or holds plausible. It is a declaration of the right of this domain to develop its own academic life, academic liberty and academic pursuits of happiness.

The university's conception of its own function and the development of men and measures to further its own aims, naturally and properly reflect, as they have ever reflected, age and people and condition. But loyalty to its own ends as conceived with such wisdom as the leaders of men could command, was and is indispensable to the academic life. The purpose must be large, the service comprehensive, the honors worthy, the career attractive to enlist the life-long devotion of ability, character and ambition. The loyalty concerned flourishes only when those who bring it feel themselves spiritually akin with the larger life with whose fortunes they have linked their own. It is

because old-time and old-land universities embody such traditions of loyalty and service that we, so distant in our pursuits, yet wander with profound appreciation in their ancient halls.

But we are modern of the moderns; and nothing is more characteristic of our heritage of all the ages than the critical analysis with which we plan and conduct our efforts. The sense of the comprehension of progressive motives and rivalry of influences has been deepened, indeed reconstructed, by the insight into evolutionary procedure that reached its first articulate expression just fifty years ago. The obligation of such insight is the duty to inquire into the forces which we shall strengthen and which antagonize, that we may remain masters of our fate. The evolutionist is neither a fatalist nor a stand-patter; he sees, foresees and directs, and he does this with the sobriety resulting from an historical conscience, and with the faith in the privilege of rational leadership. We of the academy accordingly hold to the law of the grove; that a university ancient or modern is wholly and vitally an educational institution; that the aims for which it exists are cultural; that its methods must be shaped by its own standards; that the activities of those devoted to its welfare must be freely developed from within and suitably to the cultivation of the ends for which the university alone exists. Reduced at once to its lowest and to its highest terms, the university is and can be nothing else than an assemblage of men united in the sympathy of pursuit and inspired by community of interest and a common loyalty. That the university shall attract such men and find in them the medium of her purposes, and that such men shall seek the university and find in her the enduring incentive to their best endeavors: this is the ideal that serves as the criterion of the worth of practical measures which now we approach.

We, the American people, have developed or accepted a type of university administration, to which there is no close, hardly a distant, parallel elsewhere. On a former occasion, having in mind the somewhat harsher aspects of the system, I called it government by imposition. Professor Stratton has since then proposed the more acceptable term, externalism. It is then a well-known fact that our universities are governed by boards of trustees or regents, with complete legal authority over the measures proposed by the faculty, over the status of the professors individually and collectively, and always indirectly, usually directly, over educational policies, over the larger complex issues that determine the spirit and the conditions of university advance, and naturally over the ways and means contributory to the realization of all this. In many institutions no act of the faculty is valid unless confirmed or reviewed by the board. For example, so irrelevant an issue as a case of student discipline sends an appeal to the board over the heads of president and faculty, with the not infre-

quent result that there is imposed on the faculty by direct command of the board tedious and humiliating reexaminations of a situation already properly disposed of by suitable committees. The formal statement that educational matters shall be in the hands of the faculty is for the most part evasive or ineffective. Since most matters have both aspects —financial and educational—and since the faculty can not or does not determine what measures it prefers to consider, its influence in these directions varies from a conceded control so long as no opposition is evidenced, to something merely nominal.

Such externalism of government more than any single influence has brought about the growth of another peculiarly American institution—the university president. I need not enlarge upon the heroic proportions which this majestic figure has assumed among us. It has led a professor, sympathetic with the present plea, to say that the American university has a Brobdignagian president and a Liliputian faculty. Professor Stratton regards the organization as derived from that of a colonial corporation—the financial control reserved by an absentee board in the home country, and the president representing the governor sent to the colony to direct its concerns. This historical setting may invest the organization with some interest, but it can not divest it of its dangers, nor does it account for its continuance and emphasis. Let me cite from the article to which I refer: In a country that politically is most jealous of democratic rights, "university government has assumed a form that we might have expected to see in a land accustomed to kings. European universities have a constitution that might have come from some American political theorist; American universities are as though founded and fostered in the bourne of aristocracy." "The American university president holds a place unique in the history of higher education. He is a ruler responsible to no one whom he governs, and he holds for an indefinite term the powers of academic life and death." "The polity that we might call monarchic is thus not only frequent in the new-world colleges, but it is stripping away the few lorn shreds of popular control which still remain among them."

The state of mind that has entrenched this unsuitable form of government so securely may readily be analyzed. The factors contributory to the result are several and diverse. There is a peculiarly democratic distrust of the man who knows. To call a man an expert is almost sufficient ground for a suit for libel. Conversely there is the glorification of the man who does, without too close examination of the merit of what he does and how he does it. Our captains shall be captains of industry. Business acumen in the popular mythology is Jupiter and Mars and Vulcan compositely, and properly lords it over the affairs of Athena and even of Venus. The Olympian council comfortably settled in revolving chairs in the lofty seclusion of a skyscraper summons

Apollo to make his report and engages the Muses at modest stipends upon condition of good behavior. But in truth there is no danger that the very important services of liberal-minded men of affairs to the maintenance of our universities will go unrecognized. The association of such a body as a board of cooperation is at once high token of regard for a high type of citizen, and is of definite benefit to the institution concerned. This contribution of external cooperation is quite in keeping with the genius of our national practical sense. The great and overwhelming misfortune is that its function has been so wholly misunderstood in the light of legal authority and of a popular conception growing out of relations in the business life wholly unrelated to what must and should obtain in the academic world. When the board recognizes that the university is not a business concern; that it has laws of its own; that the faculty alone can determine the mode of advance within the university, that the position of a professor is that of a counselor, free, authoritative and independent, there will be no externalism in the objectionable sense, but only external cooperation. American conditions are individual. We can not copy either the English or the German mode of government. We can secure our own type of efficiency without sacrifice of what is the essential end of all institutions of learning. Hence boards have their place, but a place determined by the subservience to the cultural ends of the university, which must ever be paramount. Business procedures must be secondary to educational ones; those who control the former should not in the least control the activities, status and decisions of those entrusted with the educational conduct of the university.

Dominated by this business view—even in its comparatively enlightened form—comes an imperious demand for results, tangible, visible, audible to the popular sense. The curve of the annual freshman crop must not compare unfavorably with that of the other indigenous products of the soil; new departments with smart heraldings must be added; the catalogue must put on pages of adipose tissue; the campus must suggest the inspiring appearance of a western town site. If a stranger had been present at a memorial exercise which I have in mind, he would have concluded that the deceased had been a mason contractor and not a college president. The addresses dwelt with loving fondness upon the buildings erected during the administration, giving the area of the floors in square feet and the cost in dollars. Now quite apart from the conspicuous and vulgar extremes of this attitude, let it be acknowledged in a meek confessional spirit that enough of it obtains in the best of our institutions to decidedly guide the direction of activities and warp them away from the path of true academic progress. This factor helps to account for both externalism and the exaggerated contours of the presidential silhouette.

As thus analyzed, the situation is explicable, in part even justified. As evolutionists we bear in mind the rapidly shifting, indeed the unprecedented character of the conditions in which our academic practises have been evolved. Under such conditions organization must be elastic, initiative open, adjustments ready to meet emergencies. Power is naturally concentrated in a few, even in a single hand; and once more, the democracy of our ideals asserts itself in the keeping in touch with popular demands of what academic service may be expected to supply. But it is still more true and very much more significant, in so far as this is an excuse, that we have outgrown all that, except where the frontier still holds. The time is here for most of our universities and is close at hand for the rest, when we must cease to ask special consideration for our educational provisions. We are not a weakling nor an unfortunate people. Let our universities stand as worthy embodiments of our national resources comparable with those of other lands, as do our railways, our factories or our public library system. This is not a matter of time, but of tradition. Some of the foremost of the German universities are about as old or younger than the college whose anniversary is now observed. But the traditions under which these were established and under which they have developed are decided traditions of the supreme right of *Lehrfreiheit* and of the great distinction and worth of the academic career. If such is to obtain amongst us we must develop perceptions keen to that which is educationally sound, to what is culturally good; we must trust implicitly those who have these perceptions; we must secure for the career devoted to this cause, honor, encouragement, responsibility, authority and a suitable living.

From whatever side we approach the situation we reach the same conclusion, for the factors thereof are of a nature all compact. We measure academic success by unsuitable standards, derived from the market-place; and as a consequence there is a sorry contamination even within the fold. That the professor has not been able to withstand these several influences must with like frankness be confessed. The law of the grove is compromised, evaded or forgotten. Professors become statistically minded, dwell upon sizes of classes, offer inducements for the hesitant student, seeks the favor of those in power and further the ends preferred by those who mete rewards. We find them also discouraged by the unfair struggle for existence, with everything rising except the price of postage stamps and professors' salaries; we find them acquiring a disturbing interest in commercial ventures; we find them losing the finer qualities of their service because of the trying elements in the intellectual climate. The excuse is not far to seek. When men of the academy find, as years go by, that their own preferment is largely determined by utility, not in direct development of their personal

ability; their activities too constantly dominated by an oppressive sense of accountability; when even their bread and butter is imperiled; when they are subjected to the humiliation of having others pass them by who have yielded where they have stood steadfast, who is there shall cast the first stone?

I had hoped to carry through my purpose without once more exposing the collegiate family expense account to the patronizing scrutiny of the affluent public. But, alas! it may not be. Bear with me in a brief "aside." The lack of proportion between the professor and his salary is regrettable yet remediable. More regrettable and I fear more difficult to remedy is the mode of determination and adjustment of such honorarium. Yet in this as in all related adjustments enlightenment is to be found in the common principle of academic supremacy. Here more than anywhere else must commercial encroachment and standards be resisted, not meekly, but strenuously. It seems plausible that if an incumbent of a professional chair is worthy to sit in the cathedra, he is worth the provision of a suitable living. The professor must not ask more nor for other reasons; the university must not offer less nor guide its offer by extraneous considerations, least of all of those that obtain in the auction room or the stock market. Professor Palmer says very plainly that Harvard University pays him for doing what he would gladly pay the university for the privilege of doing; and most professors pay and pay dearly for the privilege of the academic life. So let it be. But persistently and evasively are academic standards ignored, and ignored by those who do and those who do not understand. All honor to the few—alas the very few colleges, but among them the worthiest in the land—that have retained an academic adjustment of salaries. In the main, the influence of the college presidents has in no direction been more baneful, more insinuatingly subversive of what other merit their services have brought, than in this practise of speaking of supply and demand, the meeting of emergencies, the offset of a call from another institution, and a spurious attempt to apply a doctrine of merit and prizes. When a university president regards himself—a mere mortal—as capable to translate academic worth into dollars and cents even to the fraction of a dollar per weekly wage, I do not know whether to regard his position as an educational alchemist as sublime or ridiculous. I confess that it is astounding to me that men in this position, of such high attainments, such clearness of vision and sterling virtues, should maintain such a large and efficient blind spot when contemplating the salary question. Many a fellow professor in the mellow confidence of a growing intimacy has confided to me that he looks upon the attempt to apply such a procedure to himself as a farce, an affront or an evasion. Usually it is the last; for the answer given to Professor A is not that

given to Professor B; while Professor C, but recently refused recognition, finds that his merit has risen several points because his stock is quoted higher at a rival university exchange. Not thus is academic loyalty furthered. The salary question is a most disturbing factor of the academic situation; and the cure is prevention. Most of the irritating situations must not be allowed to arise; the ones that legitimately find their place will be suitably solved under a suitable system of principles; and the president's life, if he wishes it, will be a happier one. An equalized system of comfortable salaries fixed for the professorship and the scale of living of the environment, will dispose of this question and leave all freer to devote themselves to what their functions demand. I do not advocate for the good of the academic life the existence of large rewards or special prizes, though I deem it for the good of the community to thus manifest its appreciation of academic service. I agree with President Remsen that once the professor is relieved from financial worry the cause would not be particularly benefitted, though the professor might be pleased to receive a larger income. It is thus clear that the procedure by which incomes are to be determined and adjusted follows directly from the principles that show the way to remove far more difficult though not more irritating disabilities of the academic life.

President Remsen's remark laid him open to a retort which was promptly made: that a president would not be injured though he might be pained by having his salary reduced to that of a professor. The disparagement between the appraisal of academic and of administrative service is yet another and a serious misfortune of externalism. It affects not presidents alone, but deans, and heads of departments; it diverts unusual talents into unprofitable channels; it obstructs many of the byways of academic activity. It is thoroughly bad in appearance or reality to countenance the view that the only or the normal method of rising is by assumption of administrative powers. It is equally bad to encourage the popular misconception of academic service by throwing the limelight either upon administrative position or upon athletic prowess or upon any but the central purpose for which the university exists. It was far different in the older simplified college, in which the president was commonly the leader of the faculty, the embodiment of the spirit of the institution, distinguished for just what the academic sanction of the day approved, and quite incidentally an administrator. To-day when the office seeks the man, the search is for one with executive taste or pioneering ambition; and when the man seeks the office, it is too commonly because he likes the disposition of authority and the enjoyment of movement with no oversensitiveness to the jar or other disquieting accompaniments of locomotion. I do not for a moment imply that the university presidency is other than

a most honorable career, or that the incumbent should set aside the honorable satisfactions of high office. I do imply that a president who in any way uses the university as a means of personal exaltation is abusing his office; I do imply that such success even when most deserving and well directed is too dearly bought when it is paid for, as commonly it is, by the mutilation of the academic efficiency, often the personal unhappiness of many a professor. I imply more than this: that the spirit in which the presidency should be assumed is not wholly different from the attitude which I heard a progressive American demoiselle prescribe for her mother as a most effective way to encourage the social success of her daughters; namely, to efface herself except when summoned. Now I am not approving this rule of conduct; I am but suggesting that a large measure of this spirit of depersonalization, somewhat more loftily conceived, shall dominate all who serve the administration of the grove. Administration must ever be second; and often must it be last. Academic perspective can be retained only by an advancement to the foreground in every presentation of scientific insight, educational wisdom and commanding personal quality, by the retirement to the background of all auxiliary services however essential, difficult or worthy, so that those within and without shall see, hear and understand. Once more let me cite the testimony of another (Stratton): "We exalt administrative ability above scientific insight," which should not be. Universities "should be the last to typify in their own structure the thought that discovering truth and imparting the vital principle whereby others may discover it are of a dignity less than that of organizing and management."

I can not better reenforce the scattered contentions of my plea than by gathering a few citations from one and another who, surveying the same sets of influences in which as it seems to me lies the future strength or weakness of the American universities, have brought away a similar and even less hopeful outlook. Professor Cattell regards with special concern the autocratic domination that externalism brings and the deterioration of character that follows in its wake:

> The individual has once more been subordinated, crudely commercial standards prevail, and control has been seized by the strong and the unscrupulous. Those of us who are not ashamed to express faith in democracy regard all this as a temporary phase, which will only last until intelligence has developed equal to the complexity of the environment. The only real danger is that instincts may become atrophied before reason is ready to take their place. The trust promoter and insurance president, the political boss and government official, the university president and school superintendent, have assumed powers and perquisites utterly subversive of a true democracy. The bureaucracy is defended on the ground of efficiency; but efficiency is not a final cause. To do things is not a merit regardless of what they are, and bigness is not synonymous with greatness. There is no ground for hopelessness. Of the things done the good may last and the rest may be eliminated; bigness may become greatness.

Yet this tinge of hopefulness tends to fade when the same writer records that the

> Czar of Russia has restored to the professors the right to elect their rectors and deans at the same time that the trustees of one of the largest American universities have taken the vested right to elect their deans from the faculties without even asking their opinion or communicating to them their fiat.

The same writer says:

> The administration imposed on universities, colleges and school systems is not needed by them, but simply represents an inconsiderate carrying over of methods current in commerce and politics. The private institutions of the east, with Chicago and Stanford, have been dependent on gifts from the modern knights of industry, and the state institutions have been dependent on legislative appropriations. It is no wonder that the methods of commerce and politics have infected them. We have an absolute and absentee board of trustees, with sometimes a small group that takes an active interest in the situation, but usually an almost complete delegation of legislative, judicial and executive functions to one man, the president. When the wisdom of letting a man lord it over an aggregate of employees instead of conferring with a company of scholars is questioned, the answer is the efficiency with which the autocrat gets things done. The president gets money and students, and builds marble palaces. . . . The marble palaces may be mausoleums for the preservation of the corpses of dead ideas and monuments erected to the decay of learning.

Another student of the field—not a professor—wholly disinterested and surely unprejudiced tells us that

> Young men of power and ambition scorn what should be reckoned the noblest of professions, not because that profession condemns them to poverty, but because it dooms them to a sort of servitude.

And again:

> Unless American college teachers can be assured that they are no longer to be looked upon as mere employees paid to do the bidding of men who, however courteous or however eminent, have not the faculty's professional knowledge of the complicated problems of education, our universities will suffer increasingly from a dearth of strong men, and teaching will remain outside the pale of the really learned professions. The problem is not one of wages; for no university can become rich enough to buy the independence of any man who is really worth purchasing.

Lastly I shall cite at length and should like to cite in full a notable editorial in the *Dial*. The writer notes, as do others, that the vital difficulty lies in our mode of thinking about these problems:

> Material and commercial modes of thinking prevail so largely in our national consciousness, and impose themselves so masterfully upon our narrowed imagination, that most people are ready to accept without hesitation their extension into the domain of our intellectual concerns, particularly into that of the great concern of education. Why, it is naïvely asked, why should not the methods that we apply with such pronounced success to the management of a bank or a railway prove equally efficient in the management of a

system of schools or a university? . . . These questions are not difficult to answer but it is difficult to frame the answer in terms that the successful man of affairs will find intelligible. The subject is one that he approaches with a prejudiced mind, although his bias is not so much due to a perversity as to sheer inability to realize the fundamental nature of the question at issue. He is so fixed in the commercial way of looking at organized enterprise that he can not so shift his bearings as to occupy, even temporarily, the professional point of view. Now the idea of professionalism lies at the very core of educational endeavor, and whoever engages in educational work fails of his purpose in just so far as he fails to assert the inherent prerogatives of his calling. He becomes a hireling, in fact if not in name, when he suffers, unprotesting, the deprivation of all initiative, and contentedly plays the part of a cog in a mechanism whose motions are controlled from without. Yet the tendency in our country is to-day strongly set toward the recognition of this devitalized system of educational activity as suitable and praiseworthy, and the spirit of professionalism is engaged in what is nothing less than a life-and-death struggle. When a university president or a school principal can indulge unrebuked in the insufferable arrogance of such an expression as "my faculty" or "one of my teachers," when school trustees are capable of calling superintendents and principals and teachers "employees," it is time to consider the matter somewhat seriously, and inquire into the probable consequences of so gross a misconception of the nature of educational service.

There is one general consequence which subsumes all the others. It is that young men of character and self-respect will refuse to engage in the work of teaching (except as a makeshift) as long as the authorities in charge of education remain blind to the professional character of the occupation, and deal with those engaged in it as objects of suspicion, or, at best, as irresponsible and unpractical theorists, whose actions must be kept constantly under control and restricted by all manner of limitations and petty regulations. Membership in a profession implies certain franchise, an emancipation from dictation, and a degree of liberty in the exercise of judgment, which most members of the teaching profession find are denied them by the prevalent forms of educational organization. And the denial is made the more exasperating by the consciousness that these rights (which are elementary and should be inalienable) are withheld by persons whose tenure of authority is more apt to be based upon the executive energy or the ability of the schemer or the success of the man of practical affairs than with expert acquaintance with the conditions of educational work. The "business" president or administrative board is bad enough, and the "political" president or board is worse; yet upon the anything but tender mercies of the one or the other most men who devote their lives to the noble work of teaching must in large measure depend.

The inevitable consequence is . . . to make the teaching profession more and more the resort of the poor in spirit, to whom the words of the Beatitude must have a distinctly ironical ring. To become a teacher in this country is, except in the case of a few favored institutions or systems, to subordinate one's individuality to a mechanism, and to expose one's self-respect to indignities of a perculiarly wanton sort. Inadequate compensation is a grievous fault of our educational provision, but it is not so grievous as the faults that undermine professional self-respect, and sap educational vitality at its very root. Yet these graver faults are easily remediable, and would be promptly remedied if we could once rid ourselves of the obsession of the commercial or military type of administrative organization.

These earnest words of endorsement and appeal will serve at once to make it plain that the issue upon which I speak is a most serious one, and that I look upon it with no extreme or wholly individual obliquity of vision or personal despondency. I feel, indeed, that on a small canvas, but with large import, I have ventured to sketch the one supreme educational problem of the immediate future. Believing it also to be a practical problem, to be approached in stages of progress—stages always in their essence determined by principle, though measurably shaped by expediency—I have reserved for the last some considerations of possible reform.

And first, defensively, let us not dwell unduly upon the incompetence, the conservatism, the inadequacy in practical affairs, of faculty men. It is hardly consistent to ascribe these qualities indiscriminately to the men of the academy, and then for the most part to find in this group the very persons who develop with experience into efficient administrators. As a class, professors are able to take a helpful share in the shaping and carrying out of measures conducive to educational welfare. Their practical insufficiency is a result, not an excuse, for the present system. This has not been overlooked by other writers.

> We appear at present to be between the Scylla of presidential autocracy and the Charybdis of faculty and trustee incompetence. The more incompetent the faculties become, the greater is the need of executive autocracy of the president, and the greater the autocracy of the president, the more incompetent do the faculties become (Cattell).

And from another:

> But was there ever a more vicious circle of argument than that which defends the persistence in a system productive of such unfortunate results by urging that the personnel of the profession has now been brought so low that the restoration of its inherent rights would entail disastrous consequences? (*Dial.*)

Once given their due professional responsibility, academic men will develop—as is abundantly evidenced in the conduct of laboratories and departmental affairs—the qualities requisite for the service. The ghetto into which externalism has driven them is admittedly the least suitable habitat for the nurture of the qualities which they should exhibit; but is this an argument for the retention of the barrier?

Let us hopefully, though not blindly, look forward to as adequate a management—doubtless a simpler and saner management, with less emphasis upon managerial factors—under internal as under external control. And if there are losses, as there will be, let it be borne in mind that there will be gains to offset these, endlessly more important, in the near future as in the long run, indefinitely more worthy.

If we ask next, constructively, how shall this be brought about, let me confess that I am somewhat fearful of a policy of gradual veer-

ing, of successive short tacks to each gust of shifting sentiment. By all means evolution and not revolution; but also by all means steer and do not drift. If we are on the wrong track, let us manfully confess it and set the compass to a different course. There is already in the air a growing sentiment against autocracy, a decidedly increased willingness, even an anxiety, on the part of presidents to seek counsel and to prevent the ruptures invited by the official organization—all this parallel with an increasing development of organization upon principles antagonistic to real professional independence. It is obvious to all that so impossible a situation as that now made publicly available by the commendable willingness of Dean Kent to set forth the facts of the case is not likely to recur; and the next president of Syracuse University will be both a wiser and a happier man because of the public indignation aroused by this extreme example of presidential autocracy. Presidents are likely more and more to be benevolent, even condescending; and their efficiency is admitted. But as Professor Cattell says: "The benevolent and efficient despot is the worst kind; the cruel and incompetent despot soon disappears." The increasing graciousness and reasonableness of the administrative attitude, while it mitigates the situation for the present dwellers in the grove, must not be permitted to set aside the real need for reform. Such reform, I have urged, comes alike from the guiding dominance of principle, and the facilitation of a suitable organization. The most practical outlook is towards university presidents of different views of administration, of independent insight, not overawed by convention or popular prejudice, of a democratic temperament. I hold, as do others, that one of the first requisites is that faculties shall elect their own presidents; and the legal relations being what they are, I look forward (perhaps telescopically) to the day when no worthy man will be willing to preside over a faculty unless invited by them to this place of academic leadership. More than this, I believe it essential that the faculty invest the president with such authority and only with such as they regard as desirable for academic welfare. Professor Stratton, quite independently, has expressed the same conviction:

> Still more important and beneficial for our present needs would it be to have the professors rather than the trustees elect the university president and determine the powers which he should yield. The office of president would thus remain, but he who occupied it would be the representative directly of the faculty, and he could be efficient only so long as he retained their confidence.

Equally important with this reform is another: the authoritative voice of the faculty in the determination of what measures shall be decided with the cooperation of the board, which by the board alone, and which by the faculty alone, and with this an essential representation of the faculty at the meetings of the board. An effective provi-

sion seems to be that of a joint council of trustees and faculty, or an advisory council to the president as at Stanford University. With the establishment of these reforms or their equivalent, the rest may confidently be left to the wisdom that universities have already shown themselves to command, and to the cooperative spirit which these changes inevitably incite.

Should it be said that by my own argument, administrative methods are secondary and that the great struggle needed to effect these changes will not be justified, I reply first with a decided assent, and second with a vital reservation. Naturally administrative measures are of minor importance if academic ends are secured; but it is because the current methods are directly subversive of such ends, and because, most of all, they imperil the academic career, and wantonly deprive it of its due standing, that the change of such methods becomes the major concern of the present educational situation. "The constitution of our universities is an appearance of their indwelling mind, and therefore it is of moment for their future" (Stratton).

The outward semblance and public garb of the university, no more than personal beauty, is skin deep. Or if, indeed, we consider it such, the retort is at hand, that at all events ugliness goes right down to the bone. The unfortunate and distorted features of the academic system are not superficial; and the remedy likewise must be radical. While I make my plea for administrative reform dominantly because I am so deeply convinced that the rehabilitation of the academic career is possible only upon that condition, I yet emphasize that the welfare not alone of the profession will be secured by the change of front which is the consummation alike to be wished for and to be worked for, but equally that the good of the student community and of all that makes for the strength of the university will be similarly advanced. Measures will then be the issue of an inner harmony, of a slow maturing conviction, of sensibilities and perceptions fostered by the experience of the academic life. As has been well said, a university—like much else in this world and very different from the advertising fusilade of commercial blank cartridges—a university works best when its work is quiet and deep; and all its forms and organization should express and strengthen this idea.

Ordinarily, amid the routine of pressing duties, in the leisure between obligations, under the ever-present sense of accountability, the dweller in the modern grove checks his enthusiasms, and withstands the temptation to unfold the future. But in surroundings, such as these and under the incentive of occasion and with a sympathetic body of hearers, he is emboldened to disregard the overcast horizon and contemplate distantly, yet hopefully, the things that are to be.

THE SPECIALIST BLIGHT ON AMERICAN EDUCATION

By JAMES P. MUNROE

BOSTON, MASS.

SPECIALISM is the order of the day. From the professor of Greek down to the "professor" who shines one's shoes, that man is in demand who is disposed to concentrate all his energies upon the learning or the doing of one thing. Even our households have become infected, for therein is now to be found the very apotheosis of specialization. Even so late as the beginning of the last quarter of the nineteenth century, one maid would do substantially all the work of the house; whereas, to-day, the lady who condescends to burn one's beefsteak and to parboil one's potatoes will not enter the laundry or the dining-room, while the other maid (or maids) would join the family in general starvation before so far forgetting her "place" as to cook a single meal.

But what can be expected of the rank and file of the modern world when the leaders of American life, men in the professions and in those higher institutions which prepare for the professions, have seemingly gone mad upon the question of specialization? Like the gypsy-moth, the specialist was imported from Europe, either directly or through young men who went there for medical, linguistic or other higher studies; and many a green tree of scholarship, many a fair, broad field of general culture has been converted by this importation into a naked waste of narrow pedantry.

Of course, the time has long gone by when any man, no matter how brilliant, can, in Bacon's words, "take all learning for his province." But that does not justify the running to an opposite extreme, does not excuse the digging of a hole in the side of a small mound of erudition, getting into the farthest end of it, and maintaining that the tiny patch of sky framed by the mouth of the hole is all of the universe worth while. It is probably necessary that some man should spend his whole life grubbing at a certain obstinate Greek root; but why call him learned, when he is simply industrious? Why reward him with titles and emoluments, and give no scholastic encouragement to the far less erudite man who is nevertheless sending intellectual and moral roots over a wide area of human thought and life?

The curse of American scholarship and of American education is the Ph.D. For in exalting this decoration of the specialist, we are repeating the error of the Schoolmen, who confounded erudition,

which dries up the soul, with real wisdom, which expands man into almost the very image of the All-Wise. Yet this hall-mark of erudition is to-day practically essential as a key to a faculty position; and it is so, not because there seems any valid educational reason for it, but largely because it is required in Germany and looks well in the prospectus. As a result, hundreds of young fellows are starving themselves and impoverishing their parents in order to secure this decoration. To get it they are pursuing so-called special investigations, by counting the number of adverbial clauses in Shakespeare, or by sending out questionnaires regarding the proportion of children who twiddle their thumbs. Having scraped together this fatuous information, they are spending much time and money in having it printed, in order that another doctorial dissertation may be added to the dustiest shelves of the college library. And these most precious years of a man's life, these years in which the youth ought to be learning how to broaden his mind and capacities, how to deal with men, how to handle his faculties, his tongue and himself—these the poor fellow is selling for this mess of pottage with which to feed the trustees of some lesser or greater university.

Having been admitted to the teaching staff of the university, the fledgling Ph.D., if he is to hold his place, must produce something, and that quickly. But since his days, as a subordinate teacher, are mainly taken up in such intellect-killing work as correcting thousands of themes or counting the apparatus in the laboratory, how is he to get that breadth, experience and wisdom which alone can make what he is expected to produce of any value to the world? Half-starved physically and wholly starved intellectually and socially, his only alternative is to specialize still more, digging, like a woodpecker, into some wormhole of erudition in the hope of extracting from it a maggot large enough to placate the learned university public accustomed thus to be fed by young doctors of philosophy. This digging is politely called research; but it is the sorriest counterfeit of the genuine thing, being but perfunctory and profitless grubbing. True research must be founded upon wide scholarship, upon profound knowledge of men, and upon extensive acquaintance with the world of letters and of things. To compel such callow men as these to specialize is to condemn them to intellectual suicide and, in so doing, to kill true scholarship.

In this hard-hearted world it would not very much matter that these poor aspirants should waste their intellectual powers in this way, did it affect only them and their long-suffering wives. But it is these men, as a rule, who become professors and heads of departments, it is they who determine the atmosphere and the trend of the colleges, it is this type of specialist who is setting the standards of learning and of scholarship for America. As a result we have our college popula-

tions sharply divided into grinds and drones; we have our professions filled with men who can do much within the little cell of their speciality, but who are wholly ineffectual in the great world of human interests; we have a rich and powerful civilization that is breeding pitifully few great leaders of human thought.

There are only two kinds of simon-pure specialists allowable: the genius who has such a volume of treasure to bestow that every minute of his life should be devoted to dispensing it; and the man who is given the power of concentrated digging and who is vouchsafed no other ability. The latter will grub out the absolutely essential minutiæ without which learning can not advance. The former will call down from heaven those divine fires which are to keep civilization aflame. The number of these specialists, however, is, in comparison with the university population, infinitesimal; and the great mass of educated men need, not concentration, but expansion, an intellectual highway, not a groove. Of course, every man who hopes to amount to anything must specialize in some degree. He must have a vocation and must strive towards the highest achievement in that specialty. But he must have, in addition, avocations to broaden and harmonize and sweeten him; and even his vocation must be founded upon such a knowledge of men and of life that—at least before his fortieth year—he could take up any other vocation and succeed in that.

We specialize our grammar-school children in bank discount and leave them to life-long ignorance of what mathematics really means. We specialize our high-school youth in battles and sieges and permit them to remain ignorant of the great historic development, through industry and commerce, of mankind. We specialize our college youth in haphazard electives, each taught by a specialist and most of them unrelated to all the others, and turn that youth out of college a veritable ignoramus in regard to himself and to those other selves with whom his whole subsequent life will be concerned. We send out from our schools of applied science many a man competent to put up a bridge, but not competent to put up a good front among his equals, wise in the handling of formulæ, but ignorant in the handling of men, full of little knacks and methods of calculation, but empty of that tact and that intellectual skill which are absolutely essential to professional success.

The college teaching of literature, for example, is being dried and mummified by specialists until the study of human thought has become a sort of subterranean, philological treadmill, with never a glimpse into the wide, high, lasting things to which literature should lead. College philosophy is, as a rule, but a comparative anatomy of dead and gone systems, never, as it should be, an inspiration to wisdom, leading to the love of and search for truth. And how seldom is the

teaching of science a real search into fundamental principles and an exposition of all-embracing truths! "Facts," said Mr. Thomas Gradgrind, "facts alone are wanted in life"; and facts—the more minute the better—are the goal and joy of the specialist. But man is not an examinable fact; he is a veritable kaleidoscope of elusive impulses, impressions, ideals, fictions; and it is with man that the whole life of the educated man is to be lived.

In our schools and colleges (and especially in our professional schools), we need to get back to the humanities—not to the humanities of Greece and Rome as expounded in Oxford and diluted in America; but to the humanities of the twentieth century. For the study of the real humanities implies a working-knowledge of humankind, of men. We have been so overwhelmed with facts and discoveries and theories and inventions and names and classifications, that we are forgetting that the main fact in life is you and I. We have been so busy stuffing our children and our students with these facts that these classifications, that we are forgetting that the main things which they, as men, must know are men. Therefore give a boy, give a student all the facts and all the practise that he can get in school and college, provided you do not fail to give him, at the same time, a broad outlook upon history, upon literature, upon human experience and human life. Whether he is to start in a store, in an office or as a "drummer"; whether he is to be a minister, a lawyer, an engineer or a doctor, his success in life depends enormously upon his ability to get on with and to handle men. He can not have that success unless he is broad, catholic, tolerant, tactful and philosophical; and he can not be those things unless he has been trained, not as a specialist, but as a man. By success is not meant, of course, mere financial and professional success—though in nine cases out of ten those are most likely to be achieved by the broadest man—but that highest success which comes through the widest social usefulness, through the consciousness that one has got out of life that which has made the pains of living really worth while.

It may be an exaggeration to say that American scholarship is in a deplorable condition; but every American must acknowledge that we do not produce our due proportion of great men. There are, of course, many excuses which may properly be offered; but one of the fundamental reasons is that we permit our promising youth to specialize too soon. Consequently their scholarship, to paraphrase Bacon, is that of boys, who can talk but who can not generate. To produce men with the loins from which will spring great contributions to human thought and action we must gradually make over our whole system of elementary education so that youth, instead of being put through vast machines for imparting facts, shall be put into small classes under intellectually strong women, and especially under intellectually and morally strong

men, who shall really develop that boy's mind and character. We must then persuade the college authorities not to turn callow undergraduates into a jungle of courses taught by specialists, but to lay out for those boys really developing and strengthening coherent work which shall make them acquainted, as far as they can learn at that time of life, with men, society, philosophy and genuine wisdom. As to professional training, the physicians are getting most nearly at the heart of the problem by means of their clinics, their hospital and "externe" training, through which the embryo physician studies not simply medicine, but human nature and human life.

Supposing a youth to be really educated in school and college and to be genuinely trained in his professional school, he ought not to specialize until he shall have had a number of years of wide experience in his work, until, if possible, he shall have traveled, until he shall have taken a thorough, graduate course in the university of the world. Then he will have breadth and wisdom and true learning; then he will know real scholarship from false; then he will be humble, reverent and eager to know the truth; and only when a man arrives at this mental and spiritual condition is he fit to be a specialist. Even then, as has already been said, no man except a genius or a "grubber" is justified in being an out-and-out specialist. All others must have at least one avocation with which to temper and to put in proper perspective their chosen specialties.

SOMETHING NEW IN "FREEWILL"

BY PROFESSOR GEORGE STUART FULLERTON

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IT has been maintained that all men are born free and equal. Shall we accept this very broad statement as it stands? or shall we repudiate it as a palpable untruth, an absurd exaggeration of the actual state of things?

There can be no doubt that from certain points of view, abundant objection can be brought against it. Is a baby free to go where it pleases? Or a child of five to discipline its parents, and control the key to the pantry? Is a boy free to vote? Or to raise money on a note? Is a lady free to play poker on the curb-stone? Or a clergyman to supplement his insufficient salary by serving during the week as end-man in the performances of a minstrel troupe? Is a banker free to close his establishment every time that there is a football game between Yale and Harvard? Freedom! Where is freedom? We are all of us hedged about by restrictions of a thousand sorts, and we are not hedged about by the same restrictions. What I am free to do, another is not free to do; and what he may do is forbidden to a third. Where is this freedom attributed to all men? Some men incarcerated in cells by legal process appear to be conscious that they are not free. The larger number not thus provided for talk much about their freedom, especially at certain seasons of the year, but when we subject them to critical inspection, we find that they only seem to be free to do certain things determined by such circumstances as age, character, sex, station in life, official position, and a multitude of others. Each human being is certainly not free to do what every other is free to do. What a droll world it would be if he were!

And as for equality—talk not of it! Would any man in his senses maintain that a baby not yet "shortened" is equal in size, weight and intelligence to a senator or a college president? Is a boy equal in foresight and power of self-restraint to a man of forty? Are all schoolchildren equal in mathematical ability or in artistic skill? Are all women equally beautiful and equally talkative? The man who really believed in the equality of human beings would make the candidates for the presidency of the United States pull straws, or would toss up a copper to decide whom he should marry. Even if we confine ourselves to men as "born," as still in the cradle, we can not regard them as

equal—the hydrocephalous infant is not to be confounded with the normal child, nor the Bushman's baby with the offspring of the Anglo-Saxon.

But, it may be objected with impatience, why all this insistence upon what is so perfectly evident? Why whisper around the secret of all the world—the very first thing that our common experience of mankind brings to our notice? We do not have to wait for science to tell us that men are not so outrageously free and so ridiculously equal. Science corroborates what common experience reveals, of course; but does not every one know of himself that when we warm up over the subject of the rights of man, and grow pardonably oratorical, we never intend to be understood with a literal exactness?

Yes, everybody knows, under normal circumstances, that men are not alike, and that it would be the very height of all that is unreasonable to expect all to act in the same way. No man of sense goes to the thistle for figs, or to the penitentiary for saints. And as human beings differ, and may reasonably be expected to find the attainment of the halo difficult in varying degrees, and the descent to Avernus easy, easier or easiest, according to their proclivities and to the help furnished them by their environment, everybody knows that there is no sense in treating all men alike, if our object is, as it ought to be, the betterment of society. One man does not need special inducements to be good; one has to have a cake dangled before him; one would be cut to the quick if the cake were merely hinted at. One man needs a gentle admonition, as his feet begin to move on the above-mentioned slope; a second must have a pretty sharp jerk, if he is to be stopped in his downward career; a third whizes by with such an impetus that to lay hands suddenly upon him is to endanger his comfort and happiness. Shall we treat them all alike, and call it even-handed justice?

Everybody, I say, knows, under normal circumstances, that it is folly to expect men to act alike, when they are not alike; to look to see them influenced in the same way by the same object of desire or aversion; to hope to make them better by offering the same rewards or by holding up the same threats of punishment. The same heavy dumpling that will lure the hungry schoolboy to the paths of virtue, will drive the aged dyspeptic to the vice of imprecation.

But men only know this, be it marked, under normal circumstances. We must recognize the fact that men—not stupid men, or ignorant men, but men of the highest intelligence and of much learning—are capable of putting all this resolutely behind them, and of knowing nothing save that all men are free and equal, when they fall into the clutches of a certain strange metaphysical theory.

It is wonderful what abstract metaphysical reasonings will do. They have smothered the voice of seemingly indubitable fact, and have led

men to deny the existence of the external world. They have induced some to maintain that every man has his own truth, which is true for him; and others to advance the doctrine that no truth is attainable by man. They have caused one philosopher to talk as though he had created the world; and another to declare that there is no evidence of the existence of minds in one's neighbors. Not the least remarkable feat is the production of the persuasion—a persuasion very tenaciously held to by some—that there is something cheering and even pious in the doctrine that men's actions are, to some degree, at least, quite unaccountable, and can not be expected to be congruous with the character and environment of the person in connection with whom they mysteriously make their inexplicable appearance.

This does not at all mean that we are in a measure ignorant of what individuals and classes of men will do under given circumstances. No man denies such ignorance on our part, and all men strive to lessen it. It means that no conceivable increase in our knowledge could be expected to help us—that we are not concerned with the question of knowledge or ignorance at all. It means that certain actions have nothing to do with what has preceded them; nothing with the character of the supposed agent, but who is really not the agent; nothing with his surroundings with the influences which have been brought to bear upon him. Such actions just appear; nobody causes them, nobody can prevent them. There is no reason why they should happen in connection with one man rather than with another, or at one time rather than at another. There is nothing in any one to call them into being or to inhibit them. The baby, the grown man, the hardened criminal, the philanthropist, the dullard, the man of genius, the devoted mother, the cold-hearted coquette—all these may suffer such actions, and there is no more reason for expecting one of these to serve as the stage for their appearance than there is for expecting another to serve as such. The play has nothing to do with the stage; it may break out anywhere!

O tempora! O mores! are there those who harbor such thoughts about their fellow-men? Indeed there are; this is the doctrine of the "freewillist," stripped of its domino and set out without disguise. I am convinced that it would not even get a hearing, were it not that we often confuse it with the very different doctrine that men are under certain circumstances free, and that we come to regard it as the opposite of that very unscientific doctrine fatalism.

Of freedom, "freedom," and fatalism I have already written at some length in THE POPULAR SCIENCE MONTHLY,[1] and I shall not treat of them in detail here. But we have recently been offered some such curious "freewill" reasonings by Professor James, in that much-discussed little work "Pragmatism," that I can not but think that a brief

[1] December, 1900, and October, 1901.

examination of them will be found interesting. In any case it ought to be useful to some; for when an author writes with passion and vehemence there are those who are in danger of being swept away with the tide of his eloquence, and of forgetting that they must not close their eyes to the world of palpable and admitted fact that lies about them.

Professor James makes lively objection to the emphasis which some of us have laid upon the fact that there seems no sense in making a man responsible for what he did not do and could not prevent; in other words, in rewarding or in punishing him for "freewill" actions, which, by hypothesis, do not spring from anything that is in him, but just "happen" to the poor man. "Freewillists" have sometimes maintained that only such actions can be regarded as creditable or the reverse. It does not seem out of place for the man who sympathizes with common sense and with science to point out that to reward a man for what he did not do and can not do again, or to punish him for what he did not do and can not be prevented from having happen to him again, is highly absurd.

This answer of common sense to the position taken by the "free-willist," may, it is admitted, be good *ad hominem,* but it is declared to be otherwise pitiful. Every man, woman and child, with a sense for realities, ought, we are informed, to be ashamed to plead such principles as either dignity or imputability.

> **If a man does good acts we shall praise him, if he does bad acts we shall punish him—anyhow, and quite apart from theories as to whether the acts result from what was previously in him or are novelties in a strict sense. To make our human ethics revolve about the question of "merit" is a piteous unreality—God alone can know our merits, if we have any.[1]**

Now the common-sense determinist, that is, the man who believes in human freedom in the ordinary signification of the word—who thinks that the good man will freely choose the good, the bad man the evil, the wise man the prudent course of action, the rash and imprudent the gaming table—the common-sense determinist, I say, can have no quarrel with the position, taken by Professor James, that utility must be consulted in carrying on the social business of punishment and praise. What more natural than that the man who believes human actions to be explicable, even if not always explained, and who has confidence in the efficacy of persuasion, reward and punishment, should consult the principle of utility. He wishes to attain certain philanthropic ends; he believes that they can be attained by the employment of the appropriate means; and he turns to the means.

But the common-sense determinist, like every one else who takes an interest in ethics, must find rather paralyzing the idea that we should eliminate from ethics the notion of "merit," and should praise

[1] "Pragmatism," p. 118.

and punish without taking into consideration what is in the person with whom we are dealing. That such a doctrine should be brought forward at all, can only be explained, I think, on the ground that the "freewillist," having been brought up to think that "freewill" actions are, above all others, the actions of which ethics must take account, and now being brought to a consciousness of the absurdity of talking about the merit or demerit of "free" actions, feels driven to the extreme statement that we must banish the notions of merit and demerit from ethics altogether.

To be sure, it is hinted that we are forced to drop all consideration of merit, not because we are assured that there is no such thing, but rather because we must remain in doubt as to who may justly lay claim to it, if any may—"God alone can know our merits, if we have any." So far as our dealings with our fellowmen go, however, it is as though there were no such thing; and with merit goes demerit; and, of course, their synonyms good and ill desert go, too. We must not look upon men as deserving or undeserving, for "God alone can know" in such matters as these.

Now I beg the reader to open his eyes upon his own life and that of his companions, and to ask himself whether he would ever dream of living through a day under the guidance of such ethical principles as are here suggested. Remember that the principles are these: he who does good acts is to be praised; he who does bad acts is to be punished; no consideration is to be had to what is in the agent, he is to be praised or punished "anyhow"; no act is to be looked upon as meritorious or the reverse, as creditable or discreditable.

Think of the frightful insults which one living a day under these principles would, by his indiscriminate praise, heap upon the unoffending heads of the good—the uncalled-for compliments paid to gentle old ladies on their keeping out of street brawls; the congratulations lavished upon the president of the temperance society in view of the fact that he passed a dozen saloons without going in; the warm grasp of the hand given to the college professor for his regular and studious habits. Think of the cruelty which would result from treating all offenders alike—the mature and the immature, the case-hardened and the man who has succumbed to sudden temptation. Think of the distortion of the moral judgment which must result from embracing the opinion that nothing is creditable or discreditable to anybody. That freshmen should skip like lambs does not seem unnatural or unbecoming; but that the venerable men who are set over them should disport themselves as rams must be regarded as discreditable, I submit, by any unbiased mind.

Such a day as the one referred to above would be a day in a thousand, and its description well worthy of the pen of a ready writer.

Lack of space forbids my attempting such a description, and in any case, I lack the imagination which would do justice to it. But, to show how impossible it is to eliminate from ethics a consideration of what is in the agents whose acts we are judging, and to eliminate the notions of merit and demerit, I shall dwell upon a single illustration.

Let us suppose that we are informed that each of two human beings has, on a certain day, told a fib, appropriated something which did not belong to him, and, in an outburst of temper slapped a companion. Let us suppose, further, that we are informed that, during the whole week following that unlucky day, neither of the persons in question has done anything of the sort, but has been truthful, honest and peaceable.

On a given day, both have done "bad acts"; shall we punish both "anyhow," or, at least, give expression to our disapproval? and shall our punishment or our disapproval be equally energetic in either case? For a week both have done "good acts"; shall we praise each "anyhow," and in each case with equal warmth?

One of the delinquents is Tommy, aged four; the other is a bishop supposed to be of sound and disposing mind. May we affirm that that unhappy day has not been more discreditable to the bishop than to Tommy? And does it seem sensible to say that the week following has not been more creditable to Tommy than to the bishop? If we talk in this way about the two, we shall find that in the home, in the school, on the street, and even among the philosophers, men will laugh at us; and we can not check their laughter with the pious ejaculation that "God alone can know" whether small boys and bishops have any merits at all, or can do anything creditable or discreditable. It is only the "freewillist" who will not laugh. Metaphysical theory seems to have cast a blight upon his sense of humor.

So much for the elimination from ethics of merit and demerit. The "freewillist," who declines to consider these notions at all, has, as we have seen, fallen into error. But he has, at least, been saved from the error of arguing, as "freewillists" have done in the past, that there must be such things as "freewill" actions, if we are to accord credit or discredit to any one. The argument is very swampy ground upon which to base such an imposing structure as the "freewill" doctrine. This Professor James admits; but, as the "freewill" doctrine must be built up at all hazards, and a lot of some sort *must* be found somewhere, Professor James offers us a bit of "pragmatic" property of his own, a few square yards of "real ground," which he thinks will sustain the weight of the edifice.[3]

Persons in whom knowledge of the world's past has bred pessimism may, we are told, naturally welcome "freewill" as a *melioristic* doc-

[3] "Pragmatism," pp. 118–121.

trine. It holds up improvement as at least possible. "Freewill" is thus a general cosmological theory of *promise*.

It is very important to understand just what this means. It means that we may assume, as a relief from despondency, that things may happen in the future which have absolutely no ground in what has been or what is. We have, by hypothesis, no means of knowing anything whatever about these things to which we look forward. We can not frame a reasonable expectation of any kind—we only know that we may expect the unexpected.

Let us imagine Schopenhauer, the pessimist, and Candide, the merry optimist, banished together to a world of this lawless description, and condemned to pass a month in the same *pension*. The beds are hard, the coffee is weak, the dinner is not wholly satisfactory, and the company is mixed.

"Candide," says Arthur, after a week spent in mortifying the flesh, "how does this strike you?"

"I shall not answer you in the spirit of the exaggerated optimism which I once tried to cultivate," responds the sobered philosopher, "for the condition of things is, indeed, somewhat trying; but I know your weakness, and I feel it my duty to point out to you that, if we may not be optimists here, we may at least be *meliorists*. In such a world as this, no one can know what is going to happen next. In this general uncertainty there lies concealed a *promise*. Cheer up!"

"Cheer up?" thunders the German, "Candide, you are incorrigible. As you have abandoned your optimism, I should be ungenerous not to modify my pessimism; but beyond *pejorism* I can not, as a rational being, consent to go. You admit that things are bad; you admit that, for all we can know to the contrary, they may at any time be worse. That is enough for me—God alone can know how miserable the next week may find us."

"But think of the *promise*," insists the man of hopeful temper, "is there nothing in that?"

"The promise? The promise of what?" is the scornful reply. "Who can take comfort in a promise so long as it is uncertain whether it is a promise to pay or a promise to extort payment? Your *meliorism* and my *pejorism* are the same thing, or two aspects of the same thing —the thing may best be described as discontent with the present and complete uncertainty touching the future."

Candide relapses into silence; he can not conscientiously load the dice of "freewill" and make them work together for good. He can not assure his companion that things are going to be better, when it is purely problematic whether there is going to be any change at all, and whether, if there be a change, it will be a change for the better or for the worse. He may not exercise a confidence in the Cosmos, or in

God, or in anything, for "freewill" changes would not be "freewill" changes, if they had their ground in anything that is or has been. He sees clearly that the watchman which he has set on the wall to tell him of the night has no other task than to come down from time to time and inform him that it is conceivable that something may happen, but God alone can know what that something may be. Why keep a man out in the cold just for this? Let us rather bring him down and put him beside the fire.

And Schopenhauer is, I think, more nearly right than he usually was when he was in the body and on this planet, which science will not recognize to be a "freewill" planet. Surely it is not reasonable to take comfort in mere uncertainties as such—in promises which promise nothing. A reasonable hope, even a faintly reasonable hope, must have "some outlines and shadows" of a foundation, as Maritornes, though a sinner, had "some outlines and shadows of a Christian."

May we, then, harbor no hopes unless they are reasonable hopes? May we never hope against hope? May we never lighten dark hours by insisting that sometime the dawn must come?

I should be the last to insist that we must be as coldly rational as this. One of our problems is the problem of getting through life and of being happy and cheerful if we can. One can, as a help to this, embrace a faith, clearly recognizing that it is a faith and not a scientifically established doctrine. One can look on the bright side of things, knowing well enough that the bright side is not the only side, and yet preventing one's mind from dwelling upon what lies in the shadow.

I can not see that this would, in itself, do harm. We are concerned with a *rule of life,* and one may adopt such a rule without necessarily clouding one's intellect or repudiating the open mind. But when one undertakes to bolster up a faith adopted in this way, by the invention of arbitrary metaphysical hypotheses, which introduce confusion into the science of ethics, and which make of this orderly world in which we live a realm of anarchy, a scene of disorder, in which prudence and forethought and knowledge lose their significance—when one does this, one goes, I maintain, beyond what is permissible, and one does harm.

It has been well said that one must not judge of a man's intellect from the religious doctrines which he elects to embrace. It is the man who chooses these things; not the mere intellect. The man may be acute, and he may be learned; and he may, nevertheless, hold opinions which seem to us narrow and unenlightened. Too many things go to the determination of the religious belief of a given individual, to enable us to judge him in summary fashion.

And is it not somewhat the same in philosophy? I do not say that it ought to be just the same in philosophy; but, as a matter of fact,

is it not much the same? He who supposes that the philosophers are free from the passions of other men does not know the history of human thought.

As to the "freewill" controversy, it has been penetrated through and through with passion and with prejudice. The real impulse which makes men "freewillists" showed itself more than two thousand years ago, when a man who cared little about *meliorism* and cared a great deal about doing as he pleased without external interference, invented the "freewill" doctrine, under the mistaken notion that it released him from the decrees of fate. Some men wish to be freed from fate from higher motives, and some from lower; but freed from it we all of us wish to be. And just so long as men confuse "freewillism" with the doctrine that men may be free, will they determine at all hazards to be "freewillists."

In their desperation, men of real ability will urge arguments that are not arguments, will propose remedies that are worse than any disease likely to overtake us in the course of nature. They *must* hold on to their leaky doctrine; is not anything preferable to a surrender to the decrees of fate? But they fight a losing battle, and the exercise must be a depressing one. Is it not better to go to the common-sense determinist or to the man of science, and learn that there is no such thing as fate, and that men may be free even in an orderly world?

THE LAWS OF SOCIAL ATTRACTION

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SCIENCE is a powerful transformer of human thought and yet it is remarkable how little direct influence it has on the affairs of life. We live from day to day under the guidance of the same feelings and motives that our ancestors had long before the sway of science was felt. A new discovery attracts our attention and evokes anticipation of great changes, only to drop out of view when the novelty is worn off. Much of this lack of interest is due to the fact that the adjustments that scientific laws demand were long since made in an unconscious way so that we already do what science prescribes. A cat that, falling, lands on its feet does all that a full knowledge of gravitation demands. Law thus has a reflective use in explaining what has happened, but seldom is a force in shaping action.

There is, however, one field to which science is being applied where this conclusion does not hold. Marriage is a subject of deep personal interest and it is also one of the few fields where real choice is increasing. From generation to generation the number of those grow who settle their marriage relations for themselves. Likes and dislikes play an ever-increasing rôle, while outside pressure—be it economic, social or moral—ceases to dominate choices to the degree it did. We are forced into subordination to environing conditions to an ever-increasing degree, but we get even, so to speak, by asserting our wills more freely in the choice of mates. The economic determination of daily life is thwarted by the impulses that determine love affairs. The one free epoch of a lifetime is often the days of courtship. Can laws be formulated that cover this epoch or is the mating of men and women a matter of chance?

A notable book has recently appeared which does much to put this problem on the new basis. In his "Sex and Character" Weininger assumes that the two sexes differ so fundamentally that every organ and even every cell reflects the peculiarities of the male and female plasms from which they arise, each representing the normal results that follow from the original differences in the sex cell. He holds, however, that there are few, if any, pure males or females, but that most men inherit some female characters while in women male characters are equally common. The ordinary woman is dominantly female, not purely so. The ordinary man in turn is dominantly male

and yet some of his characters are female. If every man was a pure man and every woman a pure woman any man would be attracted by and suitable for any woman. There would be no basis for individual preference, because the qualities and impulses demanded would be found in any individual of the opposite sex. There would thus be no law of individual attraction. But with the intermediate forms—those partly male and partly female—each person likes in his mate the qualities he has not. Where he is male he demands female qualities in his mate, and where he is female he is attracted by a woman who in these respects has male qualities. A womanly man prefers a masculine woman and she in turn would be attracted by him because each finds qualities in the other that they do not possess. If the positive sign (+) be made to represent masculine characters and the negative (—) the womanly qualities then each fitting couple would have in the one a plus quality where the other had a minus quantity. Weininger states his law as follows: "For any true sexual union it is necessary that there come together a complete male (M.) and a complete female (F.) even although in different cases the M. and F. are distributed in different proportions." The truly male part of a man and the truly male part of his affinity will thus make an ideal man, while the truly female parts of the two make an ideal woman. Each wife should possess that amount of maleness that her husband lacks and he should be female to the degree and at those points where she is male. Where two people are male and female in the same qualities there will be sexual aversion with no inclination to mate.

The interest in this doctrine is increased by the application its author makes of it to the problem of woman's emancipation. The pure woman, he contends, does not want independence and equality with men. She is dominantly sexual and cares little for what is really foreign to her nature as a woman. It is the sexually intermediate forms that desire emancipation. To the degree that a woman has inherited qualities that are male she will have a deep-seated craving to acquire man's character and to have his freedom and ability. All successful women show the dominance of male characters. George Eliot, he tells us, had a broad massive forehead: her movements, like her expression, were quick and decided and lacked all womanly grace. It is this male element in women that longs for equality. The womanly woman never pays any special attention to art or to science, or if she does it is only as a means of attracting a person of the opposite sex. Women really interested in intellectual matters are sexually intermediate forms. The whole woman's movement is thus unnatural and artificial. It creates an undue amount of excitement that ends in hysteria. Any attempt to emancipate all women is sure to defeat itself by the artificiality and misery it creates.

This book is a contribution to the problems discussed, and yet I feel

that it has been put in a wrong setting and is therefore capable of a different interpretation than that which its author gives. The difficulty in applying biological principles to sociological problems is so great that any slight error leads to radically false results. Social thinkers must use biology, but care must be taken not to isolate some one principle from related doctrines which if properly presented would vitiate the reasoning drawn from a narrow field. The qualities of mothers are inherited by sons and those of fathers by their daughters, so that if there are any special sex characters they would soon appear in persons of the opposite sex. We are thus intermediate forms with characters coming both from our fathers and mothers. But it does not follow from this that sexual affinity is due to this mixture: for this would assume that we have a special liking for qualities absent in ourselves. On the contrary, we like those like ourselves and have an aversion to those who present differences no matter how slight.

The doctrine of sexual affinity should be so restricted that it will conform to sociological and psychological laws as well as to those of biology. This can be done by keeping in mind a distinction that Weininger has overlooked. Were all characters natural and none acquired, we might assume that they were male or female. But acquired characters can not thus be divided. They are carried along by a social heredity which impresses its effects on both sexes alike. Weininger assumes, however, that all characters are due to differences in germ cells and that every one in his development reveals the tendencies active in them. These tendencies, however, are thwarted by adverse conditions, so that each individual at maturity is either far short of his full development or has been pressed in other directions than forces of the original germ cell would dictate. Differences between men are thus due not merely to variations in germ cells, but to defects which arise out of bad conditions. Persons with the same germ cells may differ more radically at maturity than they differ from those whose germ cells represent some variation in the species. Food, housing, light, air and disease are of prime importance in creating the peculiarities which appear at maturity. The modifications which culminate in some variations of the racial type are in any age too slight to be of importance in accounting for the marked differences which appear in mature men and women. These differences are defects due to bad conditions, not peculiarities of germ cells. They represent retardations in development, not modification of the racial type. We are all short some characters which our heredity would reveal if conditions favored and these shortages are of such infinite variety that scarcely two individuals are alike.

It is generally admitted that improvements in the human race can be made by crosses increasing the number of natural characters. But

is sexual affinity a peculiar bond that adds to the attractiveness of other stocks and races or is it an index of defects imposed on individuals of the same stock by shortcomings of their environment? Is an affinity a person of the other sex just like ourselves in heredity, but with other defects, or is this affinity a person of other stock or race enclosed and harmonized by the influence of the same environment? The answer to these questions is to be found not in biological studies of germ cells, but in psychology and physiology. An affinity is a strong dominating form of attachment which suppresses the ordinary thought processes and puts in their place many unique emotions and illusions. We immediately recognize the abnormality of the actions of two such people and know that only the breaking of the spell will restore them to normal life. It is thus a feeling akin to hysteria and has the same general causes. Like hysteria, it is not a character, but an abnormality. It is a state of deficient emotional control—a paralysis of the higher centers that should dominate thought and activity. Irritability, passion, uncontrollable sex feelings and hysteria all represent the lack of something that is normally present, not the presence of characters absent from normal people. They are manifestations of retardations through which people fail to reach a full development. Defects represent the loss of characters due to this retardation. The higher centers fail to act with sufficient promptness and the retarded person falls under the control of strong persistent feelings that upset normal thought and control. In the parts where defects appear instead of positive characters, emotion and hysteria control instead of reason.

These persons with abnormal tendencies are aroused and dominated by the fully developed people of their own type; they have an aversion to people of other types. If a person is naturally musical, but through some defect or disease his powers are practically dormant, he will be lifted into a new realm by persons of great musical power. The capacity to enjoy music is in this defective person; it is made dormant by adverse conditions, but it can be aroused by contact with musical talent; and is forced by the new stimulus and excitement through a rapid development. There seems to be a miraculous change and with it a tremendous emotional outburst. The strong thus exert a tonic influence over the weak and retarded of their own type. The hero is not a super-man; he is the normal man; his followers are just like him in character and heredity. The defects of environment and personal development have kept them from attaining his level and give to him a dominance over their lives through the stimulus towards a better self-expression than his example and life give. The instantaneous conversion of religion does not come to the normally developed man, but he can stimulate a conversion in defective, retarded people of his own type. Strong emotions, irresistible impulses, instantaneous changes,

self-subordination to heroes and mob rule, are thus marks of defective development and of abnormal growth.

Sexual attraction is strongest between two people of the same stock with different defects. Whoever has a character of normal excellence will arouse, stimulate and subordinate one of the opposite sex who has this character in some retarded or abnormal form. If two people of the same stock have different defects each will control and arouse the other where he is normal and his mate is abnormal. The feeling of affinity is greatest when half of the faculties of each is dormant, while the normal part of each complements that of the other. Weininger asserts that two affinities taken together would show the characters of a normal man and a normal woman. I contend that the sum of their characters equals that of one normal person. He thinks that the children of these affinities will be stronger and better than the average of mankind because the qualities of their parents make a normal man and a normal woman. I contend that these children will be below the average because both of the parents are defective and the children will be subject to even more retardation in development. Let us assume that in two families on intimate terms the wife of one finds that the other man is her affinity and wants a child by him and that her husband assents promising to raise the child as his own. Weinmyer would say that this love child would be above the average of the two families, stronger in intellect and body. In my opinion it would be weaker and more defective. From his position this act should be commended; from mine it should be punished.

If I am right, Weininger is also in error in regard to woman's emancipation. He starts with the thought that the characters of men and women are different and that the emancipated woman is an intermediate form having masculine qualities. In the development of his thesis, however, he shifts over to the assumption that all positive characters are masculine and that the pure woman is nothing more than sexuality. This failure to find definite characters in woman shows the falsity of the assumption that characters are the result of sex heredity. The undeveloped man is dominated as much by sexual impulses as is the retarded woman. Positive characters that raise them above their sexual appetites come to women as to men only by the process of development. The environment of women, however, is more defective than that of men and the drains on her system are more severe. Few women go far in their development before defects become so numerous as to check further progress. If they escape these set-backs they develop the same characters that appear in men who have an unobstructed development. The emancipated woman is thus not the hysterical woman out of her normal place, but the woman with a more favorable environment than her sisters have. Her gains in character due to these

better conditions lift her to the plane of the normal man and give her his characters.

If sexual affinity is due to complementary defects and not to complementary characters it is but an example of the general law of social attraction. A social leader is not a man with additional powers to those possessed by his followers. He has a full development of all the possibilities of his heredity while they have many of these qualities, dormant or partially developed. The defective have the capacity to feel, but not the power to see or to express. They admire those who can do what they desire and feel should be done, but which they can not of themselves execute. Social affinity is thus the bond that unites the defective to the normal. The defective follow leaders not because they are imitative, but because they are stimulated and aroused. Imitation is a habit that increases the regularity of life. Emotion and hysteria result from defects that promote irregular spasmodic action. They become social only through the presence of normal individuals who subordinate the weak and defective to their own ideals. Retarded development, defects, lack of control, strong emotion and hysteria are the roots out of which social attraction grows, and the resulting law is quite as fundamental as is the law of imitation upon which so much of social thought rests.

The law of social affinity is a law not of human nature, but a law of deficit: for defects are due not to heredity, but to a bad environment. It is said that a hive of bees is a group of degenerate creatures in which just one individual is fully developed; the others are what they are and do what they do because they have not had enough food. A human society is not in so bad a shape, but individuals having their innate powers fully developed are so rare that men regard them as heroes or demigods. What these few become is the standard to which all might attain if environment, health, nurture and education were given them. We need better feeding more than better breeding. Were a higher type of beings demanded it could be secured only through the slow process of biological development, but if noble qualities are already a gift of heredity kept from expressing themselves through defective conditions, we have it in our power to lift the whole of humanity to its natural level. Income and nurture lie at the basis of social progress. To lose these essential conditions means a retarded development, unrestrained emotions and a lack of rationality in action. Reason controls the normal man; primitive emotions and hysteria control the abnormal.

Social attraction binds these defective creatures to their superiors and thus preserves the race from social degeneration, but it does not prevent physical degeneration. Sexual affinity is strongest between those with complementary defects, and hence a steady decline in phys-

ical vigor follows emotional marriages. The weak man or woman is absorbed in one individual and hates or at least is indifferent to mankind. Normality and great physical vigor tend in the opposite direction. They displace hysterical emotions with a vivid power of idealization by which the whole race becomes the object of thought; the gentle but vivid emotion of love that results goes out to all mankind and becomes personal only incidentally if at all. Love and hysteria are thus at opposite poles of physical vigor. Through idealization love imposes qualities on others they do not have and diminishes the antipathy of people to those of other stocks. It improves the race by favoring marriages that are real crosses, thus giving to children new and better qualities. The source of love is thus positive and within one's self while that of an affinity is negative, being aroused only by the presence of another defective individual. Love thus elevates and broadens while an absorbing affinity narrows and degrades.

In primitive times when the defective could not survive, emotional marriages like an emotional religion had certain advantages, and it is evident why they were both popular and useful, but when the dominance of humanitarian motives allows the weak to arrive at maturity, the power of affinity both in marriage and in religion becomes a potent force for evil. The broader interests of the race are subordinated to a narrow family and sectarian life. Vivid emotion and hysteria localize and isolate mankind into opposing groups. The marriage of affinities and the inbreeding of religious sectarians cut down the birth rate and reduce the vigor of each generation. There is thus a force that prevents degeneration even where the reduction of disease and humanitarian motives tend to permit the survival of the weak. Race suicide does in a generation what disease and brutality would have done in a few years. The increase in the number of normal people would lift men above the dangers of hysteria and degeneration and substitute rational methods for the primitive impulses that control our social life; social attraction based on a love for dissimilar people would then displace the power of affinity binding together people of the same stock. This higher bond can be secured only by transforming the defects due to economic deficits into the positive characters that would come of themselves if the mass of the people had income and leisure. Health, vigor, idealization and the love of those dissimilar to ourselves are steps in progress that follow the appearance of an economic surplus. The misleading impulses of hysteria and the narrowing grasp of affinity are the forces that mislead men in their marriage relations. Set them aside and eugenic marriages will be as common as now they are rare.

THE PASSING OF THE STURGEON: A CASE OF THE UNPARALLELED EXTERMINATION OF A SPECIES

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THERE is little chance for doubt that the sturgeon was originally present in great abundance both in the coastal and the inland waters of the United States, since frequent mention of the species is found in the annals of the colonial period. Probably the earliest mention of this fish is found in Burk's "History of Virginia," where it is stated that a sturgeon fishery existed in that colony in 1626.[1] For some reason, however, this early experiment did not prove successful and was abandoned. A century later Beverley's history of the same colony states that the rivers contained "multitudes of shad, rock and sturgeon," the last-named species being caught with nooses by the Indians. In fact, so abundant were the sturgeon that they often leaped into the canoes of the Indians, "as many of them do still (1722) every year into the boats of the English."[2] A letter from William Penn to the Free Society of Traders in 1683 names sturgeon first in the list of abundant fish in the waters of his province.[3] Throughout the region bordering on Delaware River and Bay the early settlers were struck at the immense number of sturgeon seen in those waters and here, as in Virginia, many and often fanciful stories are told about the fish being so numerous that they jumped into open boats. Even as late as 1850 it was not an uncommon occurrence for passengers on the ferry to see several sturgeon during a single trip between Camden and Philadelphia.

In the Great Lakes, on the Pacific coast, in Maine and southward from the Chesapeake, the records tell the same story of sturgeon in wonderful abundance. Yet, strange as it may seem, in those days of none too abundant food supply, the sturgeon apparently was not often eaten until many years after the colonies were established. It is not known just when this species was first made the object of a regular fishery. The unsuccessful Virginia experiment in 1626 was undoubtedly the first attempt. But after the abandonment of that venture there is no record of a regular sturgeon fishery until more than a century later. There is a tradition that before the revolution market-

[1] Burk, J. D., "History of Virginia," Vol. II., p. 17.

[2] Beverley, Robert, "History of Virginia," pp. 117–119.

[3] Watson, J. F., "Annals of Philadelphia," p. 46.

men at Trenton, then an important fishing center, packed sturgeon in barrels, shipping them to New York and to Philadelphia by ox team.[4] But until long after the colonial period, even in these places the roe was regarded as worthless except as feed for hogs or as bait for other fish. Furthermore, few people of the better class would eat the flesh, it being the food of servants and negro slaves.[5] The reason for this prejudice is not recorded, but it is not unlikely that it was similar to the early prejudice against the Connecticut River shad on the ground that it was food for Indians. It is true enough that this objection, though equally applicable, did not prevent the colonists from consuming large quantities of oysters. But the difference in the edible qualities of oyster and sturgeon combined with the no less great abundance of the more highly esteemed shad, might readily explain the inconsistency. At all events, that the strong prejudice did exist is beyond question, hence there seems to be room for some doubt about the importance of this Trenton fishery of the colonial period.

In the "History of the Fisheries and Fishing Industries of the United States," edited by G. Browne Goode, it is said that a large sturgeon fishery, employing a score of vessels in some years, was carried on in Maine during the early part of the eighteenth century, but was not followed continuously. The account does not state to what use the products were put nor where they found a market. Again in the first quarter of the last century a company of men located on a small island in Casco Bay and began fishing for sturgeon, sending the flesh in kegs to the West Indies. The business was soon suspended for unknown reasons, however, and although there was an abundance of sturgeon in the Kennebec there was no further attempt to utilize them, except for occasional home use, until many years later.[6]

Despite these various experiments at sturgeon fishing in different localities, the strong prejudice against the sturgeon flesh appears to have precluded the possibility of developing any regular market, and so prevented the growth of any important industry, until after 1850. It seems probable that the first approach to a regular and permanent fishery was developed in the Delaware River region. About 1830 and later, three Pennsylvania fishermen made a practise of taking sturgeon with nets and harpoons near the present town of Bristol, Pa. They also did some fishing about Dutch Island, near Bordentown, while on the other side of the Delaware a gill-net fishery was begun in 1853 at Penn's Grove, New Jersey.[7] That the occupation here was not very remunerative, however, can be seen from the fact that the fish rarely sold for more than 30 cents each and often as low as 12½ cents.

About the same time, a third attempt was made in the Kennebec

[4] *Fishing Gazette*, July 21, 1906, p. 679.
[5] U. S. Fish Commission Report, 1899, p. 370.
[6] Goode, Vol. V., Sec. 1, p. 699.
[7] U. S. Fish Commission Report, 1899, p. 370.

by representatives of a Boston firm, their object being to put up the roe for caviar and manufacture oil from the bodies. No difficulty was experienced in securing a supply of fish, 160 tons being caught the first season. The oil obtained was of excellent quality, but the experiment with the roe, one of the earliest in the country, was a failure, and after two seasons this venture went the way of its predecessors.

The Delaware River industry, evidently as a result of its proximity to New York and Philadelphia, where more convenient markets could be found among the foreign population and poorer classes, appears to have struggled along with a more or less precarious existence until about 1860. A few years prior to that date, the smoking of sturgeon flesh had been begun on a small scale in New York, and was followed by a similar custom in Philadelphia. Smoked sturgeon made a fairly good substitute for smoked halibut, and in this way a more or less regular demand for the flesh was for the first time created in the cities, being supplemented by the growing "wagon trade" carried on by peddlers who carted fish through the country districts.[8] The preparation of sturgeon roe for caviar had also been done successfully on a commercial scale and was perhaps even a more important factor in promoting the growth of the fishery. But as an important industry, the sturgeon fishery of Delaware River and Bay can not be said to have originated much before 1860 to 1870, at which time, so far as the records show, the Hudson River was the only other place where it gave promise of attaining extensive proportions. Maine was once more the scene of a sturgeon fishery in 1872, when local fishermen engaged in it, giving place two years later to a regular crew, headed by New York fishermen, catching and buying for the New York smoking and caviar establishments.[9] Important fisheries in the Hudson River existed prior to 1880, supplying local demands or the markets in Albany and New York. The former city is said to have taken such quantities of the flesh that it came to be known locally as "Albany beef," like the sobriquet "Charles city bacon" applied to sturgeon meat on the James River, in Virginia.[10] The Maine fishery, however, ceased to be important after five or six years, and never was revived, and the Hudson industry had declined greatly before 1880, because of the scarcity of fish. During this same period, Delaware River fishermen had developed a regular fishery for sturgeon about the mouths of the larger rivers along the South Atlantic coast, the most important localities being Albemarle Sound, Savannah River and Winyah Bay.[11] But regular fishing was also prosecuted near the mouths of the Altamaha, Satillas, Ogeechee, Edisto, Santee and the various streams enter-

[8] U. S. Fish Commission Report, 1899, p. 370.
[9] Goode, Vol. V., Sec. 1, p. 699.
[10] Goode, Vol. V., Sec. 1, p. 659.
[11] U. S. Fish Commission Bulletin, 1891, p. 355.

ing Winyah Bay.[12] In most cases the fishermen were from northern localities, going south to engage in the industry before the season opened in Delaware Bay, and sending their catch to the Savannah market, or to New York and Philadelphia, *via* Charleston or Savannah.[13]

In other localities, however, the sturgeon was somewhat slower in being rid of the strong prejudice against it, to which was added in many cases the bitter enmity of the fishermen because of the damage done to their nets by this powerful fish. The salmon fishermen of the Columbia River despised it as a worthless, destructive fish, and for many years whenever taken in the nets a sturgeon was usually killed or thrown out on the bank. Along the shores of the Great Lakes sturgeon were not used very much for food until after smoking of the flesh began at Sandusky about 1860, experiments in making caviar having been tried at that place five years earlier.[14] Before that time they had been so little valued that when it was possible to sell them they would not bring over 10 cents apiece,[15] while in most cases they were regarded as a nuisance, usually being taken out and thrown away. As late as 1872, in fact, sturgeon were taken in great abundance every autumn in the nets of the Green Bay region and were almost universally pulled into the boats and consigned to the offal heap.[16] From Virginia, also, comes the statement that less than three decades ago the roe was thrown away or used for fish bait, and such great quantities of meat were taken in the Potomac that there was absolutely no sale, the fish being piled like cordwood on the shore and farmers called on to cart them away for fertilizer.[17] In the face of these conditions, however, the sturgeon fishery by 1880 had become an important branch of the fishing industry in the Middle and South Atlantic States and in the Great Lakes. Successful smoking of the flesh and its use as a good substitute for smoked halibut had overcome much of the early prejudice and established a small, but growing, market for sturgeon meat, while the manufacture of isinglass from the bladder and, most potent of all, the increasing European demand for caviar, aided materially in establishing the industry on a profitable basis. Instead of being thrown out in heaps to rot as before, the multitudes of sturgeon in the Great Lakes were now turned to profit by the fishermen. Where in 1860 the sturgeon had supported only a tottering industry, confined largely to the Delaware River region, the year 1880 marked an industry widespread in its range and yielding nearly 12,000,000 pounds of products annually.

[12] Goode, Vol. V., Sec. 1, pp. 617–625.
[13] Goode, Vol. II., p. 506.
[14] U. S. Fish Commission Report, 1887, p. 249.
[15] *Loc. cit.*, p. 263.
[16] U. S. Fish Commission Report, 1872–73, p. 10.
[17] *Fishing Gazette*, January 20, 1906, p. 56.

For nearly two decades after 1880 the annual yield of sturgeon products did not fall below eleven or twelve million pounds, but as season followed season the same areas were not contributing the same proportion of the total. The accompanying table shows the catch for the various districts in different years. In 1880 the Great Lakes,

STATISTICS OF THE STURGEON FISHERY [18]

	1880		1890[19]	
	Pounds	Value	Pounds	Value
New England	.....	.....	2,800	$132
Middle Atlantic	1,719,558	$65,553	5,847,527	144,255
South Atlantic	1,055,150	58,899	487,787	10,374
Gulf	.....	.....	.....	.....
Pacific Coast	1,658,000[22]	.....	2,309,294	38,019
Great Lakes	7,557,383[22]	.....	4,289,759	148,360
Interior	.....	.....	.....	.....
	11,990,091		12,937,167	$341,140
	1897[20]		1904[21]	
	Pounds	Value	Pounds	Value
New England	21,310	$1,256	21,260	$2,112
Middle Atlantic	3,698,905	191,926	736,313	91,708
South Atlantic	1,042,230	56,178	238,855	25,483
Gulf	31,654	1,315	478,496	17,098
Pacific Coast	3,139,511	80,094	137,981	4,271
Great Lakes	1,176,818	111,389	638,898	53,017
Interior	2,250,209	62,693	1,008,408	38,355
	11,360,637	$504,851	3,260,211	$232,044

owing to the vast abundance of sturgeon in the shallow and warmer waters of Lakes Michigan and Erie, yielded more than three fifths of the total for the United States. Although complete statistics for the entire country are not available for any single year during the decade following 1880, there is ample reason for believing that the industry expanded and the products increased rapidly for several seasons. For example, the catch in the Lakes was only 410,000 pounds smaller in 1885 than it was in 1880,[23] and in 1888 the chief coastal areas, the

[18] Statistics from following sources: Goode, Vols. II., V., Sec. 1. Report of the U. S. Fish Commission, 1888; 1893, p. 146; 1895, p. 495; 1896, p. 576; 1899, pp. 109, 175, 372–80; 1900, pp. 200, 319; 1901, pp. 511, 580; 1902, pp. 440, 484; 1903, pp. 348, 416; 1904, pp. 648–51. Bulletin of U. S. Fish Commission, 1890, p. 78; 1891, p. 281; 1894, p. 350. Fisheries Documents 609, 620; Statistical Bulletin 188.

[19] Statistics are for years as follows: New England, 1889; all others, 1890.

[20] Statistics are for years as follows: New England, 1898; Pacific coast, 1895; Great Lakes, 1899; Interior Waters, 1895; others, 1897.

[21] Statistics are for years as follows: New England, 1905; Middle Atlantic, 1904; South Atlantic and Gulf, 1902; Pacific Coast, 1904; Great Lakes, 1903; Interior Waters, 1903.

[22] No values given.

[23] U. S. Bureau of Fisheries Report, 1904, pp. 649–51.

Middle Atlantic, South Atlantic and Pacific coast states, yielded an aggregate of nearly eight and a half million pounds as compared with less than four and a half million pounds in the earlier year.[24] Every pound of this increased coastal yield in 1888, however, was due to the expansion of the Delaware River and Bay fishery, which in that year produced over 6,400,000 pounds. But even this phenomenal catch is said to have been smaller than it had been a few years before.[25] It seems safe to conclude, therefore, that in 1885 the combined sturgeon catch in the Lakes and in the Delaware region alone was not less than 25 per cent. greater than the total product of the whole country in 1880. If this be true the total catch in the United States must have ranged at least somewhere above 16,000,000 pounds in 1885. It was the demand for caviar in European markets and especially in Germany which had more than anything else made the fishery profitable and caused it to rise almost in a single decade, 1875–1885, to an industry of important proportions among the valuable fisheries of the country.

By 1890, almost every district was beginning to show the effects of the vigorous fishing which had swelled the total catch during the early years of the decade. The declining supply was most marked in the lakes, where the catch had fallen off by nearly three million pounds in five years. The Middle Atlantic States then stood first, the quantity taken from the comparatively small expanse of Delaware Bay exceeding the entire lake catch by nearly a million pounds,[26] the total being over three times as great as it had been in 1880, but distinctly less than the amounts reported in the intervening years. In the South Atlantic States also there had been extensive declines in the sturgeon products,[27] but since the catch in these areas increased to a marked degree in subsequent years it seems necessary to suppose that the low catch of 1890 was due in part, at least, to other causes than scarcity of fish. Along the Pacific coast, on the other hand, marked expansion was taking place in the years preceding and subsequent to 1890, as the result of a successful sturgeon industry established on the Columbia River in 1888. Vast quantities of sturgeon had been observed by the fishermen ever since the salmon fishery had begun two decades before, but all that time the sturgeon had been looked on as a nuisance and "in most cases was knocked on the head and set adrift in the river."[28] The abundance of the supply available can be seen from the fact that two years after the business was started the catch rose to nearly 1,700,000 pounds, and to more than 3,000,000 pounds in 1892. This important increase in the Pacific coast district, combined with the greater extent of the Delaware

[24] U. S. Commission Report, 1888, "Statistical Survey of the Coast Fisheries of the United States."

[25] U. S. Fish Commission Bulletin, 1888, p. 278.

[26] U. S. Fish Commission Report, 1899, p. 372.

[27] U. S. Fish Commission Bulletin, 1891, p. 281.

[28] U. S. Fish Commission Report, 1893, p. 250.

fishery as compared with ten years before, accounts for the greater yield for the country in 1890.

Statistics of the sturgeon fisheries in the scattered inland waters of the country were collected for the first time in 1895 and added a little over 2,250,000 pounds to the total.[29] The major portion, over two thirds, of this quantity came from a single area—the Minnesota waters of the Lake of the Woods. The same year showed continued large catches in the waters of Washington and Oregon, though a comparison of the totals with the figures for a few years before indicates a growing scarcity of fish and an impending decline.[30] The Carolinas and Georgia, however, were again yielding as much as formerly, having recovered at least temporarily from the low condition of 1890. The activity in these three areas helped to offset the appalling decline which had continued uninterrupted in the lake region and the Delaware district, as indicated by the statistical surveys of 1897. The lakes in 1897 produced scarcely more than one fourth as much as they had in 1890, and New Jersey, which alone had yielded over 3,600,000 pounds in 1890, barely exceeded 1,000,000 pounds seven years later.[31] On account of these tremendous losses in the supply from the waters of early importance, the total yield of the country had fallen only a little more than half a million pounds below the figures for 1880, but over a million and a half pounds below the total for 1890, and at least six million pounds below the catch of 1885.

Two factors had played a leading part in maintaining the industry against such odds as are represented in the depletion of the Great Lakes and Delaware River sturgeon. First of all the rising price of caviar was a powerful incentive to pursue sturgeon fishing with increasing vigor wherever a profitable catch could be made. Caviar which had brought from $9 to $12 per keg of 135 pounds in 1885, was worth $20 five years later, $40 in 1894, and before the end of that decade had risen above $100 per keg.[32] Sturgeon roe was no longer fish bait and feed for hogs, and few sturgeon found their way to the offal heap, at least, until after the precious ova were removed. Flesh too was mounting upwards in price, reaching as high as 12½ cents per pound in 1896, where a decade and a half before sale had often been impossible at even one cent per pound. From 1882 to 1884 female sturgeon would bring as high as $2 each at the wharf, whereas fifteen years later the usual price was $30 to $35 each. In the spring of 1899, for example, 96 sturgeon at Bayside, New Jersey, brought $3,923, an average of a little over $40 apiece.[33] Nowhere else in the whole

[29] U. S. Fish Commission Report, 1895, p. 495.
[30] U. S. Fish Commission Report, 1896, p. 576.
[31] Bureau of Fisheries Report, 1902, p. 460.
[32] U. S. Fish Commission Report, 1899, p. 379.
[33] Pennsylvania Fish Commission Report, 1900, p. 171.

annals of commercial fisheries is there a parallel to this case of the sturgeon, rising as it did in less than a quarter of a century from a fish despised and ruthlessly destroyed on all sides to the highest rank of commercial value.

The high prices for caviar resulted in continued operations in the old localities even in the face of greatly reduced hauls. This condition is nowhere better illustrated than in the Delaware district, where the average catch per net dropped from 60 fish in 1890 to less than half that number six years later.[34] Yet in 1897 nearly 1,000 fishermen were operating over 150 miles of gill nets in the sturgeon fishery of Delaware Bay and the number of boats employed had actually increased.[35] At the same time operations were extended and expanded in every available new area to supply the growing demand and to profit from the rapidly rising prices. The sturgeon fishery in the Gulf States was begun at this time because of the increasing scarcity of the species in northern waters.[36] The south side of Long Island was the scene of an important fishery begun in 1892, producing more than half a million pounds of products five years later,[37] while the yield from interior waters, though steadily decreasing, was annually forming a larger proportion of the total output of the country. Only by most vigorous means was the total extent of the industry maintained anywhere near its former level, while the fishermen to eke out profits were endeavoring to utilize more of the sturgeon by the manufacture of oil and fertilizer from the carcass.

By 1897 the sturgeon fishery attained the highest point of its commercial value, over half a million dollars, while at the same time it appears to have reached its limit of endurance under the strain of incessant demand placed upon it. In the decade elapsed since then there has been only decline—decline almost universal and astounding in its extent. In many places, the sturgeon is practically extinct and in others, where once important fisheries were prosecuted, the industry is nearly abandoned. New York and Pennsylvania waters have almost ceased to yield sturgeon products despite the half million pounds from Long Island in 1897. The same condition appears in the Carolinas, while the species has entirely disappeared from the waters of Eastern Florida and Oregon. On the Pacific coast, as a whole, where more than 3,000,000 pounds were taken in 1895, less than four per cent. of that quantity was obtained in 1904. The Middle Atlantic area as a whole and the Great Lakes are now yielding less than one tenth the amount caught two decades ago. Lake St. Clair, which alone gave nearly a million pounds in 1880 has not produced more than 10,000

[34] U. S. Fish Commission Report, 1899, p. 371.
[35] *Ibid.*, pp. 379–80.
[36] Bureau of Fisheries Report, 1903, pp. 443, 445.
[37] Bureau of Fisheries Document 609, p. 29.

pounds in recent years, while the catch in Lakes Michigan and Erie has fallen to about one sixtieth of its former proportions. In the Delaware River district, the most prolific of all the sturgeon grounds ever developed in this country, the depletion of the supply has gone almost to the point of extinction. The total amount yielded from the nets of the three states bordering the river and bay has dropped from more than 5,000,000 pounds in 1890 to less than 350,000 pounds in recent years.[38] A quarter of a century ago these waters still literally teemed with sturgeon, and it was impossible to dispose of all that could be caught. Then it was not an uncommon thing to see 1,000 or more sturgeon on the wharf at Bayside, New Jersey, with shipments of five or six carloads in a day to New York or Philadelphia. In recent years to see a score of sturgeon on the wharf at one time has been a rarity enough to bring the fishermen from miles around to see them, and if five or six boxes are shipped at the same time the shippers think they are lucky. Less than twenty years ago 4,000 to 5,000 kegs of caviar were shipped annually from the Delaware district and dominated the market under the name of Russian caviar. But the total caviar output had fallen to 726 kegs in 1899,[39] and at Delaware City, an important center, where 422 kegs of caviar were prepared in 1895, only six kegs were obtained in 1901, with even less since then, while the price has been soaring above $1 per pound. It is a condition without parallel in the annals of fishing.

With the single exception of the smaller rivers entering the Gulf of Mexico, where the fishing for sturgeon dates only since 1897,[40] all the grounds show evidence of the same rapid depletion. On every hand, declines of 90 to 95 per cent. in the last decade or two mean only the one thing—that the end of the sturgeon is near unless the most active and rigorous protective measures are speedily adopted.

This amazing depletion of a fish once "marvelously abundant" must be regarded largely as a natural or at least inevitable outcome of the character of the fishery itself. More or less weight must, of course, be given to the amount of wanton destruction of the sturgeon by the river and lake fishermen of successive decades before the sturgeon fishery was established on a commercial scale. Certain injurious and wasteful methods of fishing have also been employed at times, the worst of which was the use of small mesh nets both by sturgeon fishermen and by others, destroying many young sturgeon, the use of the three-pronged grappling hook dragged over the spawning grounds, particularly at the eastern end of Lake Erie, and most of all the unrelenting pursuit of the fish during the spawning season. The object of the

[38] U. S. Fish Commission Report, 1888; 1896, p. 576; 1899, pp. 109, 372; 1901, pp. 511, 580; 1903, p. 345; 1904, p. 648.

[39] Pennsylvania Fish Commission Report, 1900, pp. 170–71.

[40] Bureau of Fisheries Report, 1903, pp. 443, 455.

fishery, however, has always been chiefly to obtain the roe for caviar. Hence the spawning time was the most favorable period for profitable operation, and the fishermen, with their characteristic disregard for the future, by incessant fishing practically eliminated natural reproduction. When the lake whitefish supply began to fail the fishermen were required by law to return the spawn to the spawning grounds, and when the Atlantic coast shad showed signs of depletion vigorous work at artificial propagation was largely capable of counteracting the effect of too much fishing. But the case of the sturgeon was quite different, in that the profitable prosecution of the fishery depended mainly on the amount of roe secured. In many cases, in fact, no other portion was utilized until comparatively recently, when the price of the flesh advanced. Obviously then a most serious difficulty stood in the way of the adoption of those measures which had benefited fisheries for other species. The high value of the hard ova to the fishermen and their inability to use the soft or ripe ova in caviar have meant the most vigorous efforts to secure the roe before it became soft. The United States Fish Commission, and the states of Pennsylvania, New Jersey and Delaware, have repeatedly tried sturgeon hatching individually and in cooperation, but the difficulty experienced in securing ripe spawn and milt at the same time has brought failure.[41] The fact is, in the Delaware district, at least, the species is so nearly extinct, and males so scarce, that even when ripe ova are secured a male may not be taken for several days or too late to be of any use. It is hard to see how this condition can be easily remedied. With artificial propagation more or less impracticable and natural reproduction reduced to an absolute minimum, the fate of the sturgeon is obvious.

It is true, however, that some efforts have been made to prevent the complete extermination of the sturgeon and to protect the existing remnants of the formerly important fishery. The principal efforts have been made through legislative action placing certain restrictions on the operations of the fishermen. These restrictions fall into two groups, first, making it unlawful to take sturgeon under a given size, and second, prohibiting all sturgeon fishing at certain seasons. The states bordering on the Great Lakes furnish the best illustration of the first group of laws. Ohio in 1896 prohibited the capture of sturgeon less than 3½ feet long; Pennsylvania passed a similar law in 1901, and New York adopted a minimum length of 3 feet in 1902. Michigan and Wisconsin, on the contrary, based their restrictions on weight, the former, in 1897, setting 15 pounds as the lawful size, and the latter, in 1903, prohibiting the capture of sturgeon under 8 pounds.

These laws do not seem to have produced the desired result or in

[41] Bureau of Fisheries Report, 1902, p. 460. Pennsylvania Fish Commission Report, 1905, p. 64; 1906, p. 23.

fact any important result at all, for the fishery has continued to decline steadily since the laws were enacted. The trouble, however, lies not so much in the provisions of the law itself, as it does in the difficulty of adequate enforcement. The Lake areas are in this respect no different from other localities, since laws protecting the young sturgeon of the Delaware have been in operation from 1891, yet the fishery in those waters has declined at an extremely rapid rate, and to a greater extent than in almost any other region.

The other alternative of statutory protection, the close season, has received less common trial because the only time at which a close season has any value is during the spawning period, and at that time the fishery is most profitable. The scarcity of such laws is probably due to the fact that restrictive legislation affecting the fisherman's profits has always been notoriously difficult to pass. Georgia, however, in 1901 prohibited catching of sturgeon in all waters of the state for a period of five years. Minnesota in 1905 adopted a close season from March 1 to May 1 of each year, but at the next session of the legislature the Georgia example was followed in the provision for a close season at all times until June 1, 1910. This sort of law seems to afford the only real remedy for existing conditions. Complete prohibition is, of course, much easier to enforce than partial prohibition, because where sturgeon roe can be legally taken at all the carcass can be disposed of readily and it then becomes a difficult matter to prove that the fish from which the roe was taken was undersized or underweight.

With the difficulties confronting artificial hatching and the adequate enforcement of restrictive measures, the future of the sturgeon fishery depends on the absolute cessation of fishing for a period of years during which the supply can be replenished through natural reproduction. Otherwise the total extinction of the species is as inevitable as was the depletion of the supply. This chain of conditions is not peculiar to the United States, but has prevailed in all the older localities wherever the fishery has been prosecuted. Yet it seems scarcely comprehensible that a fish so widely distributed through the country, so abundant, and so little used less than three decades ago, has so rapidly disappeared that the end is already in sight. The higher the price of caviar, the more vigorous the pursuit of the sturgeon and the more quickly the end will come. Under the present conditions it is only a question of a few years until the day of the sturgeon fishery will have passed.

FOREIGN ASSOCIATES OF NATIONAL SOCIETIES

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MEMBERSHIP in societies is, in general, a poor test of the qualifications of a scientific man. The case is very different, however, if we consider only the foreign associates of the principal national societies or academies of the world. Their organization differs in different cases, but, in general, each is divided into several sections, of which that relating to the physical and natural sciences will alone be considered here. The members are divided into two or more classes which are called by various names. First, resident members, who live in the vicinity, pay fees and practically own the society. Secondly, foreign associates, who, as they have few duties or rights, and as the position is a purely honorary one, are selected wholly for eminence in a particular science. Their number is generally limited and on the death of one, a typical method of selecting a successor would be as follows: The matter would first be referred to a committee of resident members in the same department of science. These specialists would report one or more candidates, and the final selection would be made by the entire body of resident members. Doubtless injustice may be done in individual cases, but it is hardly possible that an unworthy person could secure membership in many foreign countries. It is sometimes stated by those unfamiliar with the facts, that a candidate can not be elected without personal effort on his own part. This is incorrect, as to my personal knowledge in at least half a dozen cases the notice of his election was the first intimation a candidiate had that his name was under consideration. It is possible that, in some cases, a candidate may have aided his election, but it would be a dangerous experiment, as many persons would vote against him for this reason only.

Ten countries, not including colonies, have a population of more than twenty millions: China, 432,000,000; Russia, 146,800,000; United States, 86,400,000; German Empire, 60,600,000; Japan, 49,700,000; Austro-Hungarian Empire, 47,000,000; Great Britain, 41,500,000; France, 39,000,000; Italy, 32,500,000; Congo Free State, 30,000,000. The population of Brazil is 19,900,000; of Spain, 18,900,000; of Mexico, 13,600,000. Omitting these, and China, Japan and the Congo Free State, we have the seven great nations of the world. The national or principal scientific societies of each of these countries is

given in Table I. The name of the country, the name of the society, the year of its foundation, and the date of the list of members employed in the following discussion are given in the successive columns.

TABLE I.

SOCIETIES

Country	Society	Founded	List
Russia.	Imperial Academy of St. Petersburg.	1725	1903
United States.	National Academy of Sciences.	1863	1908
Germany.	Royal Prussian Academy of Sciences.	1700	1908
Austria.	Royal Academy of Sciences.	1847	1907
Great Britain.	Royal Society of London.	1645	1908
France.	Institute of France.	1795	1908
Italy.	Royal Academy of the Lincei.	1603	1908

A list was next prepared of the foreign associates of each of these societies. It appears that there are 87 persons thus honored by two or more societies. Their names are given in the first column of Table II., in alphabetical order. The present residence is given in the second column. The department of science is given in the third column, generally taken from that assigned by the Institute of France, or the Academy of the Lincei. These classifications, which are nearly identical, are geometry, mechanics, astronomy, geography (including navigation), physics, chemistry, mineralogy, botany, agriculture, zoology (including anatomy), and medicine (including surgery). The year of birth is given in the fourth column, and the age at the time of election in the following columns. The letters, R, U, G, A, B, F and I represent the seven societies named above, respectively. The age is placed in italics to indicate resident membership. Thus, italics are used, in the column headed R, in the case of all Russians. No account has been taken of elections or deaths occurring after January 1, 1908.

In using Table II., it is extremely difficult to treat all nationalities with equal fairness. Thus, a resident in one of the seven great countries can be a foreign associate of only six of the societies. A Russian could never be a foreign associate of the Russian Society, while a Swede might be an associate of all seven. The numbers in italics in Table II. are much smaller than the others, which shows that less eminence is required for election as a resident member, than as a foreign associate, or perhaps that a man's work is better known at home than abroad. In a few cases, a man is elected into a foreign society who is not a member of the home society. This seldom occurs except in Germany, where a Bavarian, for instance, might be elected into the Austrian Society, before he was elected into the Prussian Society. Complications also occur when a resident member of a society moves into another country. Fortunately, these conditions affect a few men only. On the whole, the simplest and fairest plan seemed to be to

TABLE II.

LIST OF MEMBERS

Name	Country	Science	Birth	R	U	G	A	B	F	I
Agassiz, A.	U. S.	Zoology	1835	...	*31*	60	54	56	52	53
Auwers, A.	Prussia	Astronomy	1838	35	45	*28*	56	41	54	50
Bachlund, O.	Russia	Astronomy	1846	*37*	57	...	...	...	49	...
Baeyer, A. von	Bavaria	Chemistry	1835	57	63	*39*	50	50	51	59
Becquerel, A. H.	France	Physics	1820	...	85	84	...	...	*69*	83
Beneden, E.	Belgium	Zoology	1846	56	...	41	56	...	55	53
Bornet, E.	France	Botany	1828	74	73	...	...	...	*38*	...
Brögger, W. C.	Norway	Mineralogy	1851	47	52	...	...	51	53	...
Butschli, O.	Baden	Zoology	1848	46	...	*49*	56	...	...	...
Cannizaro, S.	Italy	Chemistry	1826	63	...	62	63	63	69	*47*
Chauveau, J. B. A.	France	Agriculture	1827	...	...	...	...	62	*59*	63
Christie, W. H. M.	England	Astronomy	1845	47	...	...	...	*36*	51	...
Darboux, J. G.	France	Geometry	1842	53	...	55	65	60	*42*	48
Darwin, G. H.	England	Geography	1845	...	59	...	...	*34*	62	52
DeVries, H.	Holland	Agriculture	1848	...	56	...	...	57	...	54
Ehrlich, P.	Prussia	Medicine	1854	...	50	...	...	...	...	53
Engelmann, T. W.	Prussia	Medicine	1843	...	...	*55*	52	...	52	58
Fischer, E.	Prussia	Chemistry	1852	47	52	*41*	50	47	48	47
Gaudry, J. A.	France	Mineralogy	1827	...	...	73	...	68	*55*	70
Geikie, A.	England	Mineralogy	1835	...	66	54	60	*30*	56	63
Gill, D.	England	Astronomy	1843	42	55	47	...	*40*	53	63
Gordan, P.	Bavaria	Geometry	1837	...	...	*63*	...	...	67	67
Groth, P.	Bavaria	Mineralogy	1843	40	62	...	...	...	...	62
Haeckel, E.	Saxony	Zoology	1834	...	...	...	38	...	...	65
Hann, J.	Austria	Geography	1839	51	...	50	*33*	...	...	...
Heim, A.	Switzerland	Mineralogy	1849	...	...	...	...	47	57	...
Helmert, F. R.	Prussia	Geography	1843	...	...	*57*	...	...	56	54
Hering, E.	Saxony	Medicine	1834	...	...	...	61	68	...	65
Hilbert, D.	Prussia	Geometry	1862	...	45	...	...	...	...	41
Hill, G. W.	U. S.	Astronomy	1838	...	*36*	...	...	64	65	...
Hittorf, W.	Prussia	Physics	1824	...	...	*62*	...	...	76	80
Hoff, J. H. van't.	Prussia	Chemistry	1852	43	49	*44*	44	45	53	49
Hooker, J. D.	England	Botany	1817	41	66	54	...	*30*	49	58
Huggins, W.	England	Astronomy	1824	77	80	71	...	*41*	50	59
Jordan, M. E. C.	France	Geometry	1838	57	...	...	...	...	*43*	57
Karpinski, A.	Russia	Mineralogy	1847	*49*	...	...	50	...	...	51
Klein, F.	Prussia	Geometry	1849	46	49	...	51	36	48	34
Koch, R.	Prussia	Medicine	1843	41	60	*61*	60	54	60	45
Kohlrausch, F.	Prussia	Physics	1840	54	61	*55*	...	55	...	59
Kronecker, U.	Switzerland	Medicine	1839	..	62	...	...	...	...	58
Lancaster, E. R.	England	Zoology	1847	48	56	...	...	*28*	52	51
Leydig, F. von	Wurtemberg	Medicine	1821	76	...	*66*	...	80	...	...
Lippman, G.	France	Physics	1845	...	...	55	...	51	*41*	...
Lister, J.	England	Medicine	1827	...	71	...	70	*33*	66	...
Lockyer, J. N.	England	Astronomy	1836	...	...	...	...	*33*	37	47
Lorentz, H. A.	Holland	Physics	1853	...	53	52	...	52	50	49
Mascart, E. E. N.	France	Physics	1837	54	...	58	...	55	*47*	62
Michelson, A. A.	U. S.	Physics	1852	...	*36*	...	...	50	48	54
Mittag-Leffler, G.	Sweden	Geometry	1846	50	...	...	...	50	54	53
Nansen, F.	Norway	Geography	1861	37	...	...	...	...	34	39
Nathorst, G.	Sweden	Botany	1850	51	...	50	36	...	...	...
Neumayer, G. B. von	Saxony	Geography	1826	...	...	*70*	77	73	...	...
Newcomb, S.	U. S.	Astronomy	1835	61	*34*	48	69	42	39	60
Noether, M.	Bavaria	Geometry	1844	...	...	*52*	...	...	59	47
Ostwald, W.	Saxony	Chemistry	1853	43	53	*52*	51	...	...	...
Pawlow, I. P.	Russia	Medicine	1854	*47*	...	...	...	53	...	53
Pfeffer, W. F. P.	Saxony	Botany	1845	...	58	*44*	59	52	55	54
Pflüger, E. F. W.	Prussia	Medicine	1828	66	...	*72*	...	60	...	71
Picard, E.	France	Geometry	1856	39	47	42	...	...	*33*	45
Pickering, E. C.	U. S.	Astronomy	1846	...	*27*	60	...	61	61	55

TABLE II.—*Continued*

LIST OF MEMBERS

Name	Country	Science	Birth	R	U	G	A	B	F	I
Poincaré, H.	France	Geometry	1854	41	44	42	49	40	*33*	34
Ramsay, W.	England	Chemistry	1852	49	52	44	51	*36*	43	55
Ranvier, L. A.	France	Zoology	1835	47	...	...	...	...	*42*	53
Rayleigh, J. W.	England	Physics	1842	54	56	54	60	*31*	48	59
Retzius, G.	Sweden	Zoology	1842	53	...	51	59	65	53	65
Righi, A.	Italy	Physics	1850	46	...	...	...	57	...	*48*
Roscoe, H. E.	England	Chemistry	1833	...	...	...	...	*30*	53	74
Rosenbusch, H.	Baden	Mineralogy	1836	...	68	*51*	68	...	63	65
Sars, G. O.	Norway	Zoology	1837	59	...	61	...	...	...	...
Schiaparelli, G. V.	Italy	Astronomy	1835	39	...	44	39	61	44	*40*
Schultze, F. E.	Prussia	Zoology	1840	55	...	*44*	44	...	...	...
Schwarz, H. A.	Prussia	Geometry	1843	54	...	*49*	...	...	52	45
Schwendener, S.	Prussia	Botany	1829	...	...	*50*	70	...	71	70
Strasburger, E.	Prussia	Botany	1844	...	54	*45*	...	57	56	49
Suess, E.	Austria	Mineralogy	1831	70	67	69	*36*	73	58	52
Thompson, J. J.	England	Physics	1856	...	47	...	...	*28*	...	47
Thomsen, J.	Denmark	Chemistry	1826	...	...	74	...	76	...	57
Treub, M.	Java	Botany	1851	...	...	49	...	48	37	...
Tschermak, G.	Austria	Mineralogy	1836	...	...	45	*39*	...	61	47
Valdeyer, H. G. G.	Prussia	Zoology	1836	58	...	*48*	71	...	68	...
Van der Vals, J. D.	Holland	Physics	1837	...	...	63	...	...	63	66
Van Tieghem, P. E. L.	France	Botany	1839	...	...	...	51	...	*38*	66
Walcott, C. D.	U. S.	Mineralogy	1850	45	*46*	...	...	...	...	51
Warming, J. E. B.	Denmark	Botany	1841	...	...	58	...	...	63	65
Wiesner, G.	Austria	Agriculture	1838	...	...	61	*54*	...	...	64
Zeuthen, H. G.	Denmark	Geometry	1839	...	...	...	...	...	61	63
Zirkel, F.	Saxony	Mineralogy	1838	...	65	*49*	45	59	...	61

count the numbers in the last columns of Table II., thus including the home societies. The results are nearly the same as if we omit the home societies and diminish the numbers in each case by one. The formation of the table by requiring membership in at least two foreign societies is a slight advantage to those not resident in the seven great countries, but they lose when italic numbers are included. The table furnishes the means of making a count with any other conditions, but it is not probable that the general conclusions would thus be changed.

Before discussing the results of Table II., it may be well to apply certain tests to it. The English Order of Merit includes the names of Huggins, Lister, Hooker and Rayleigh. They are all contained in Table II. and are members of 6, 4, 6 and 7 societies, respectively. Great care is taken in awarding the Bruce medal. The six living medalists are included in Table II., the number of societies being 7, 7, 6, 6, 6 and 5, respectively.

Four of the seven societies confer a special honor on a few of their foreign associates by granting them the privileges of resident members, or by placing them in a special class of honorary members. The names and years of elections are as follows: Russia: Newcomb, 1896; Nansen, 1898; Suess, 1901; Schmoller, 1901; Wundt, 1902. Prussia: Hittorf, 1900; Suess, 1900; Pflüger, 1900; Hooker, 1904; Schiaparelli, 1904; Baeyer, 1905. Austria: Schiaparelli, 1893;

Hering, 1896; Lister, 1897; Hoff, 1903; Koch, 1903; Agassiz, 1907; Baeyer, 1907. France: Lister, 1893; Newcomb, 1895; Suess, 1900; Hooker, 1900; Schiaparelli, 1902; Koch, 1903; Agassiz, 1904. As the number selected is nearly the same in each of the four societies, it might be expected that several of the men would be chosen by all. Of the fifteen men, no one was selected by all four societies, two were selected by three, six by two, and according to Table II. with one exception belong to either six or seven societies. Seven men were elected as honorary members of one society only, and the names of two of them do not appear in Table II.

Nearly every other honor than that of foreign associate depends on other considerations than eminence. Thus, honorary degrees from the great universities are often regarded as an excellent test of distinction. But many universities give degrees only when candidates are present, and accordingly, one who always remained at home, from illness or other causes, would be at a great disadvantage. This is still more markedly the case with decorations, which are often given for services rendered, or to the representative of a country, wholly independently of his personal eminence.

Table III. gives for each country represented in Table II., the name, the population, the number of members belonging to 7, 6, 5, 4, 3 and 2 societies, respectively, and to all combined. The total number of memberships is given in the next column. Thus, if there were two members each belonging to 5 societies, and one belonging to 4, the total membership would be 14. The average number, or the number of memberships divided by the number of members, is given in the following column. The population expressed in millions divided

TABLE III.

COUNTRIES

Country	Population	7	6	5	4	3	2	No.	Soc.	Av.	Mill.
Prussia	37,300,000	4	1	2	5	3	2	17	77	4.5	2.0
England	30,800,000	2	4	1	2	4	.....	13	63	4.8	2.4
France	39,000,000	1	1	2	2	6	.....	12	49	4.1	3.0
United States	86,400,000	1	1	1	1	2	.....	6	28	4.7	14.4
Saxony	4,500,000	.....	1	1	1	2	1	6	23	3.8	0.8
Austria	47,000,000	1	.....	.....	1	2	.....	4	17	4.2	11.8
Bavaria	6,500,000	1	.....	.....	.....	3	.....	4	16	4.0	1.6
Italy	32,500,000	.....	2	.....	.....	1	.....	3	15	5.0	10.8
Sweden	5,300,000	.....	1	.....	1	1	.....	3	13	4.3	1.8
Holland	5,600,000	.....	.....	1	.....	2	.....	3	11	3.7	1.9
Russia	146,800,000	.....	.....	.....	.....	3	.....	3	9	3.0	48.9
Norway	2,200,000	.....	.....	.....	1	1	1	3	9	3.0	0.7
Denmark	2,600,000	.....	.....	.....	.....	2	1	3	8	2.7	0.9
Baden	2,000,000	.....	.....	1	.....	1	.....	2	8	4.0	1.0
Switzerland	3,300,000	.....	.....	.....	.....	.....	2	2	4	2.0	1.6
Belgium	7,100,000	.....	.....	1	.....	.....	.....	1	5	5.0	7.1
Wurtemberg	2,300,000	.....	.....	.....	.....	1	.....	1	3	3.0	2.3
Java	28,700,000	.....	.....	.....	.....	1	.....	1	3	3.0	28.7
All	489,900,000	10	11	10	14	35	7	87	361	4.1	5.6

by the number of members, is given in the last column of the table. Thus, Prussia, which has a population of 37,300,000 furnishes 4 men who are members of all 7 societies, 1 of 6, 2 of 5, 5 of 4, 3 of 3, and 2 of 2, making 17 in all. The number of memberships is 77, or an average of 4.5 societies to each member. On the average, one Prussian in 2,000,000, appears in Table II.

From an examination of Table III. it appears that, with the exception of one botanist from Java, who should perhaps be added to the group from Holland, no member resides in Asia, Africa, South America or Oceanica. With the same exception, no member comes from a colony or subsidiary country. The only members from North America are from the United States, and no members come from Scotland, Ireland or Wales. The number from the United States is no greater than that from Saxony which has about one twentieth the population. This is in part offset by the fact that the two English speaking nations, England and the United States, show a higher average number of societies per member than any other nations except Italy and Belgium. The very small ratio of members to population in Russia is largely due to the vast sparsely settled tracts of that country where advanced intellectual work is impossible.

Grouping the members according to cities, we have, Paris, 12; London, 10; Berlin, 10; Vienna, 4; Leipzig, 4; Stockholm, 3; St. Petersburg, 3; Copenhagen, 3. It will be noticed that, with the exception of Leipzig, each of these cities is the capital of its country. All the members from France, Austria, Sweden, Russia, Denmark and Java come from the capitals of those countries. Of the entire 87, 58 or nearly two thirds reside in capital cities. The average membership of these men is also higher, being 4.3 for those in capitals and 3.9 for the others. Ten cities contain two members each, and seventeen, one each.

A grouping according to the sciences is given in Table IV., in a form similar to Table III. The successive columns give the name of the science, the number of members in 7, 6, 5, 4, 3 and 2 societies, respectively, the total number of members, the total number of societies, the average number of societies per member, and four columns indicating the country to which the members belong. The first of these columns headed G, for Germany, includes Prussia, Saxony, Bavaria, Baden and Wurtemberg; E includes England and the United States; F, France; M, the other countries.

In eight of the sciences, the number of members is fairly distributed, varying from 8 to 11. None appear in mechanics, 3 only in agriculture, and 5 in geography. The grade, or average membership is remarkably high in chemistry, 5.5, with astronomy second, 4.9. The average for all is 4.1. Of the 10 members belonging to all seven societies 4 are chemists. The distribution according to nations is

TABLE IV.

SCIENCES

Name	7	6	5	4	3	2	M	S	Av.	G	E	F	M
Geometry	1	2	1	2	3	2	11	45	4.1	5	.....	4	2
Mechanics	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Astronomy	2	3	1	.....	4	1	10	49	4.9	1	7	.....	2
Geography	.....	.....	.....	1	4	.....	5	16	3.2	2	1	.....	2
Physics	1	.....	3	2	5	.....	11	45	4.1	2	3	3	3
Chemistry	4	1	.....	1	2	.....	8	44	5.5	4	2	.....	2
Mineralogy	1	1	2	3	3	1	11	46	4.2	3	2	1	5
Botany	.....	2	1	1	5	.....	9	36	4.0	3	1	2	3
Agriculture	.....	.....	.....	.....	3	.....	3	9	3.0	.....	.....	1	2
Zoology	.....	2	2	1	3	2	10	39	3.9	4	2	1	3
Medicine	1	.....	.....	3	3	2	9	32	3.6	6	1	.....	2
All	10	11	10	14	35	7	87	361	4.1	30	19	12	26

instructive. In geometry, France has 4; Prussia, 3; Bavaria, 2; England, 0; United States, 0. In astronomy, England has 4; United States, 3; Prussia, 1; France, 0. In medicine, Prussia has 4; Bavaria, 2; England, 1; France, 0; United States, 0.

A grouping according to the seven societies is given in Table V. The name of the country is given in the first column, followed by the number of members belonging to 7, 6, 5 4, 3 and 2 societies, respectively. Of course, the number belonging to 7 societies, 10, is the same for all. The total number of members in Table II. is given in the next column, followed by the number in each society who have so far failed to be elected into any other society (except perhaps that of their own country) and are, therefore, not included in Table II. The sum of the last two columns is given in the next column, and gives the total number of foreign associates. The ages of the youngest and oldest foreign associate in Table II., at the times of their election into each society, are given in next two columns.

TABLE V.

SOCIETIES

Society	7	6	5	4	3	2	II.	T	All	Y	O
Russia	10	8	5	6	16	1	46	30	76	35	77
United States	10	7	8	6	7	3	41	5	46	44	85
Germany	10	10	9	9	16	1	55	14	69	41	84
Austria	10	8	3	6	9	1	37	9	46	36	77
Great Britain	10	11	7	7	15	1	51	8	59	36	80
France	10	11	8	12	19	2	62	24	86	34	76
Italy	10	11	10	10	23	5	69	39	109	34	83
All	70	66	50	56	105	14	361	129	490	34	85

The order in which members were elected into each society, furnishes a test of the care with which candiadtes were selected. Thus, if the ten members of all seven societies had been elected into one society first, and afterwards into all the others, we should say that that

society had displayed great skill and discernment in its selection. In fact, the Imperial Academy of St. Petersburg elected four of these men before their talents were discovered by any other foreign society on this list, and two of them before they were elected by the home society. If one society was always the last to elect we should suspect that it awaited the judgment of others, in which case its choice would have little value as an independent opinion. It might, however, be due to other causes, as, for instance, a higher standard, if its total membership was less. A society which elected many members who were never elected into any other would appear to show poor judgment, although other conditions might enter in particular cases. Thus, every member must, for a time belong to one society only. The failure to detect marked differences by these tests confirms the view that the selections are made independently and fairly.

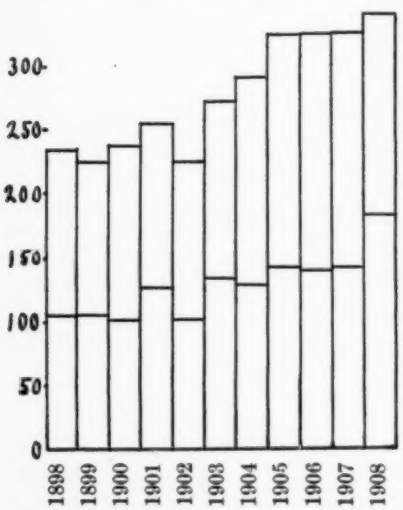
An examination of Table II. reveals some interesting cases. One member was elected into the six foreign societies in five years, while with another this period extended over thirty years. One was elected into all seven societies before he was fifty years old. One has been elected into the six foreign societies for eight years, and has not yet been elected into the home society. One was elected into three foreign societies before he was forty. Three persons have been elected into a foreign society after attaining the age of eighty, and ten before they were forty. About two thirds were elected into foreign societies between the ages of forty-five and sixty-five. On the average, these men were elected into their first foreign society about eight years after election into the home society. The successive elections then took place at average intervals of three years and a half. The oldest member is ninety-one, the youngest forty-six. Many other conclusions regarding age might be drawn, such as its relation to country, science or society, but no striking differences have been noticed.

The most important conclusions to be drawn by inhabitants of the United States, are that the representation per million inhabitants is less than a fifth that of the principal countries of Europe. We have no representative in mathematics or medicine, while in astronomy we have three out of ten members. The explanation is not hard to find. While immense sums are spent on higher education in this country, the endowment for advanced research is comparatively small. Astronomy is almost the only science having institutions devoted to research, and in which a large part of the time and energy is not expended in teaching. Of the six American members, five have occupied positions in which no teaching was required, but their entire time was supposed to be devoted to original investigation.

THE PROGRESS OF SCIENCE

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

For the past eleven years there has been published in *Science* each summer an article on the degrees of doctor of philosophy and doctor of science awarded by American universities. It appears from these statistics that during this period 42 institutions have given this highest academic degree to 3,093 students. The number in each consecutive year is represented graphically by the height of the column in the accompanying figure. It thus appears that, with fluctuations from year to year, there has been a decided increase in the number of those officially designated as competent to teach and carry forward research work. The annual number first exceeded 250 in 1901 and 300 in 1905. After remaining stationary for about three years, it is this year 378. The middle lines in the columns represent by their distance above the base line the number of degrees in the natural and exact sciences, the balance of the space to the top of the column representing the number in the so-called humanities, including under this term history and political science. It thus appears that nearly but not quite half the degrees are given in the sciences and that there is a slight tendency for the sciences to gain on the humanities.



DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

Three fourths of the 3,093 degrees have been conferred by seven universities as follows: Chicago, 410; Harvard, 380; Columbia, 377; Yale, 350; Johns Hopkins, 333; Pennsylvania, 257; Cornell, 203. The universities of the Atlantic seaboard, with Chicago, thus hold the position that Germany had twenty years ago. As Americans then frequented the German universities for advanced work, so now they tend to go to these seven universities which are private corporations, though perhaps Cornell and Pennsylvania are on the way to become state institutions. The great state universities of the central and western states will probably witness a large development of their graduate schools in the course of the next ten years, and the south will follow the same course in the following decade. Wisconsin gave 17 degrees this year and 19 last, more than double the average for the preceding ten years. Illinois, which this year received the first special appropriation made to a state university for graduate work, conferred five degrees, as many as had been conferred in the preceding ten years. Michigan, Minnesota and California have, however, remained nearly stationary.

About twice as many degrees are conferred in chemistry as in any other science. The numbers have been: chemistry, 374; physics, 177; zoology, 172; psychology, 157; mathematics,

144; botany, 137. There is then a drop to geology with 76, physiology with 48 and astronomy with 35. University work in chemistry is often a professional course for the chemical analyst or engineer and is thus not altogether parallel with the other sciences. It would be well if similar conditions obtained in engineering and the medical sciences, so that there would be larger numbers from which those competent to undertake research work might be selected.

The universities differ in the relative emphasis placed on the sciences and the humanities. Thus at Cornell and the Johns Hopkins nearly sixty per cent. of the degrees are in the sciences, whereas at Harvard, Yale, Columbia and Pennsylvania the percentage is about forty. At Chicago the percentage is 49, at New York University it is only nine, and at Boston University only two. It is commonly supposed that the state universities are mainly occupied with the utilitarian sciences, and it is interesting to note that at Wisconsin, Michigan and Minnesota, respectively, 77, 60 and 70 per cent. of the degrees are in the humanities.

The three or four hundred young men added each year to those engaged in the advancement of science and learning are probably the most important factor in our civilization. Not more than half of them will accomplish anything after their doctor's theses, but the others may perhaps have their places filled by those who enter research work otherwise than by the ordinary academic routine. When we remember, however, that about 5,000 physicians and lawyers are graduated each year, the number taking the doctorate of philosophy seems to be small —not in proportion to the population and wealth of the country. There are some 25,000 professors and teachers in our colleges and universities and some 35,000 in the secondary schools; then there are increasing numbers of positions in the government service and elsewhere. The supply of men of the right kind does not equal the demand, and one of the most serious problems that confronts us is to find methods to increase the numbers and improve the quality of those engaged in scientific research.

AERIAL NAVIGATION

THE center of interest—dramatic, practical and scientific—at present is in the demonstrations of aerial navigation now being made in France and here, especially by Mr. Wilbur Wright at Le Mans and by Mr. Orville Wright at Fort Myer. But the changes are so rapid—at the time of this writing Mr. Orville Wright has broken the record four times in four consecutive days—that only the daily newspapers can follow them. A scientific journal, however, should not go to press without an expression of admiration for the work of those who have so successfully applied scientific principles to the solution of practical problems, and it is not chauvinistic to betray satisfaction in the fact that the United States, in the scientific and applied work of Langley, Chanute and Bell and now in the practical success of the Wright brothers, has led the way.

It may be that flying-machines will only be used in war and in sport, but history has shown time after time that it is not safe to set limits to what science can accomplish. It almost seems to be a longer step from Langley's first experiments to what the Wright brothers have now done, than from this to complete mastery of aerial navigation. It would of course be impossible to accomplish this otherwise than through gradual progress in many directions. What is most needed at present is an engine of increased efficiency for its weight. Should this be devised, the problem would be much simplified. The dangers of aerial navigation are more obvious than real. It is now safer to go down to the sea in ships than to ride along a road on a horse. There is plenty of room in the

EXAMPLES OF SUBMARINE PHOTOGRAPHY.

air, and it may be found in the end that this advantage will more than counterbalance the chances of falling to the earth. However these things may be or whatever may happen or not happen, there is every reason to congratulate Messrs Orville and Wilbur Wright on their great achievement and on the careful scientific research which preceded it and on which it rests.

This is true in spite of the catastrophe that has occurred since these words were put in type. It appears that government officials are responsible for requiring the premature delivery of an aeroplane that would carry two persons. To an outsider it would seem that ballast should have been tried, and that protective clothing should have been worn.

THE PHOTOGRAPHY OF AQUATIC ANIMALS IN THEIR NATURAL ENVIRONMENT

AT the seaside laboratory of Roscoff, in 1893 and subsequently, Dr. L. Boutan made the first submarine photographs by means of a submerged camera. He was not successful with a camera immersed directly in sea water, owing to the lack of a suitable lens, but got clear and good photographs with cameras enclosed in water-tight boxes, both with sunlight and in deeper water

with the use of the magnesium flash-light and electric arc lamps. Since that time excellent aquatic photographs in aquaria have been made by Dr. R. W. Schufeldt, Mr. A. R. Dugmore and others, but the photography of fishes and other subaquatic life has by no means reached the degree of perfection that has recently been obtained in photographing birds and wild mammals in their natural habitats.

Professor Jacob Reighard, in a recent bulletin of the Bureau of Fisheries, has taken up the subject and describes methods of subaquatic photography, both when the camera is outside the water and when it is submerged. The former method must be used when the water is shallow, and good results can be secured when ways are found by which the light reflected from the surface of the water is cut off and a smooth surface is obtained. In deep water, however, and for many purposes it is necessary to use a submerged camera. Professor Reighard describes the apparatus he used at the Tortugas, and examples of the photographs taken are here reproduced. According to Professor Reighard's description, in the upper picture a butterfly-fish (*Chætodon capistratus*) with a stripe through the eye and an eye-like spot on the tail is seen over a flat expanse of coral (*Meandrina*) and at the base of a large, branching

ALBRECHT VON HALLER.

Eminent as physiologist, botanist and poet, the two hundredth anniversary of whose birth will be celebrated by the University of Bern on October 15.

gorgonian. The photograph was taken while the fish was in rapid movement. The expanded polyps may be seen on the gorgonian just above the fish and elsewhere. The lower picture shows a group of parrot fishes, of at least three species, and several surgeons against a background of branching gorgonians on a ledge of rock. Near the center is a blue and yellow-striped grunt, *Hæmulon flavolineatum*. At the left of this is a blue parrot-fish, *Callyodon cæruleus*. At the right of the grunt is a green parrot-fish, *Callyodon vetula*, about eighteen inches long. Beneath the green parrot is a mottled parrot-fish (*Sparisoma?*). Above the grunt is a second mottled parrot and to the left of this a third. At the extreme left are two surgeons, *Hepatus hepatus;* a third is seen below the green parrot. Above the green parrot, in the background, is a purple sea fan, *Rhipidoglossa*. In most of the fish the details of the markings and the outlines of the scales are clearly shown in the original photographs.

Subaquatic photographs such as these show a lack of distinctness which appears to be due to the turbidity of even the clearest water and to reflected light. But, as Professor Reighard points out, the lack of distance and flatness of the objects are truthful representations of the conditions that actually obtain. From the artistic point of view, they can not be regarded, therefore, as defects, though from the scientific point of view they place limitations on subaquatic photography.

SCIENTIFIC ITEMS

We record with regret the death of M. Antoine Henri Becquerel, the eminent French physicist, and of Dr. Friedrich Paulsen, professor of philosophy at Berlin.

Professor C. O. Whitman, head of the department of zoology in the University of Chicago, has resigned the directorship of the Marine Biological Laboratory, Woods Hole, Mass., which he has held for the past twenty years. Professor Frank R. Lillie, of the University of Chicago, the assistant director, has been elected to the directorship.—Mr. F. J. Seaver, assistant botanist of the North Dakota Agricultural College, has been appointed director of laboratories in the New York Botanical Garden.—Professor Rufus I. Cole, of the Johns Hopkins University, has accepted the directorship of the Research Hospital of the Rockefeller Institute of New York City.

By the will of the late Senator William F. Villas the University of Wisconsin will ultimately receive his entire estate, valued at between two and three million dollars. By the provisions of the will, Mrs. Villas receives the income during her lifetime, and after her death her daughter receives $30,000 a year. After the property is given to the university, part of the income will be reserved until the principal becomes $30,000,000. The will provides for the erection of a Henry Villas Theater, and for the establishment of ten professorships, each with a salary of not less than $8,000, nor more than $10,000 a year. —By the will of Frederick Cooper Hewitt, Yale University receives $500,000; the New York Post-graduate School and Hospital $2,000,000, and the Metropolitan Museum of Art $1,500,000 and the residue of the estate. —An anonymous gift of $100,000 has been made to the Vienna Academy of Sciences for the establishment of a "Radium Institute" in connection with the new physical laboratories of the University of Vienna.